Sky and TELESCOPE

In This Issue:

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Sky and TELESCOPE

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COVER: Comet Arend-Roland, as it appeared from an altitude of about 7,000 feet in the mountains east of Los Angeles, California, on the evening of April 24th. The picture was taken by Alan McClure, a member of the Los Angeles Astronomical Society, with an Aero-Xenar lens of 320 millimeters focal length, aperture 80 millimeters. The camera was set on a small equatorial mounting with electric clock drive and slow motions, guided through a 3-inch refractor. The exposure was for 10 minutes, from 7:47 to 7:57 p.m. Pacific standard time. The enlargement from the 4-by-5-inch negative (emulsion Kodak 103a-E) is nearly 2½ times in this reproduction. (See page 364.)

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QUESTIONS... FROM THE S+T MAILBAG

Q. How do I hold a star chart to make it match the appearance of the sky?

A. Hold the chart over your head, with the side labeled "north" turned in that direction, "east" pointing east, and so forth. Sky directions on a naked-eye star chart seem reversed from those on terrestrial maps because we see the stars as if they were on the inside of the celestial sphere, whereas we are on the outside of the earth.

Q. What is stellar parallax?

A. The parallax of a star is defined as the angle subtended by the average radius of the earth's orbit, as seen from the star. It is observed as a small yearly variation in the position of a star due to seeing it from different portions of the earth's orbit. The larger this parallactic angle, the nearer the star. Yet the parallax is always very small; for the nearest star system, Alpha Centauri, it is only 0.75 second of arc, which corresponds to a distance of 4.3 light-years.

Q. What part of a telescope is called the objective?

A. It is the part that gathers the light and focuses it to form an image which is examined with the eyepiece. Although it may be either a lens or a mirror, many writers use *objective* to mean only a refractor's lens. They use the term *primary* for the mirror of a reflector.

Q. What is meant by "1950 co-ordinates," an expression often used on the Observer's Page, for example in connection with the position of a star cluster?

A. Owing to the precession of the earth's axis around the pole of the ecliptic, there is a continual displacement of the celestial co-ordinate system with respect to the stars; it amounts to almost a minute of arc per year. Therefore, the right ascension and declination of a star change from year to year. Star atlases show the co-ordinates for a particular date or epoch, which is 1950 for the widely used Norton and Skalnate Pleso atlases.

***Q.** What is the average velocity of the earth in its orbit, and how much does it change during the year?

***A.** The earth revolves around the sun at an average rate of 29.8 kilometers per second, or 18.5 miles per second. At perihelion the earth's velocity is 1.7 per cent more than this, at aphelion it is 1.7 per cent less. W. E. S.

*This question and answer are repeated from page 326 in the May issue, in order to correct the erroneous earth speeds given there. The mistake was pointed out by Dr. P. van de Kamp, Sproul Observatory, author of the book, *Basic Astronomy*.—ED.

Comet Arend-Roland on the evening of April 25th, photographed by Freeman D. Miller with the 24-36-inch Schmidt telescope at Portage Lake, Michigan. Besides the broad main tail, a bright narrow spike, which pointed sunward, was especially prominent at that time, when the comet was about 58 million miles from the earth. The picture scale is one inch to 550,000 miles. The exposure was 20 minutes long on a 103a-O (blue-sensitive) plate without filter. Because the comet was low in the sky, the telescope's position prevented accurate guiding. University of Michigan Observatory photograph.

Comet Arend-Roland Is Widely Observed

OBSERVERS around the world enjoyed the spectacle of a bright naked-eye comet, the first in a decade, during late April. This was the object discovered last November 8th at Uccle Observatory, Belgium, by Sylvain Arend and Georges Roland. When they first photographed the comet, in the constellation Triangulum, it was of only the 10th magnitude. By the end of February it had brightened practically to naked-eye visibility, but was becoming too close to the sun in the evening sky to be seen.

According to a report from New Zealand, cited in *Circular* 1595 of the International Astronomical Union, J. G. Gow was able to see the comet on April 2nd, only 5½ days before perihelion passage. His view through light haze gave the magnitude of the comet as about 2.0. At this time the comet, being south of the sun, was visible only from the Southern Hemisphere, with considerable difficulty.

During the interval from April 3rd to 11th, Comet Arend-Roland was seen by at least three of the expeditions to Antarctica for the International Geophysical Year. These were the Australian mission to Mawson Land, the New Zealand party at Scott Base, and the French expedition to Adelie Land. The third group reported the comet as between 3rd and 4th magnitude on April 6.8, Universal time, with a tail three to five degrees long.

A photograph was secured by K. Gottlieb and A. Przybylski at Mount Stromlo Observatory, Australia, on the morning of April 11th, with the 26-inch Yale-Columbia refractor. This picture, which is on a very large scale, shows only the nucleus and its immediate surroundings; it suggests that the nucleus was perhaps double, with a separation of about nine seconds of arc. The Australian observers first saw the comet with the unaided eye on that date; on the 14th they judged it as probably not brighter than 1st magnitude.

After perihelion Comet Arend-Roland moved rapidly northward into the evening sky. On the 20th and 21st of April it appears to have been seen by many persons in Europe and North America. By the 23rd, the comet was between Alpha Persei and Gamma Andromedae. Dr. G. Van Biesbroeck, who determined the comet's position with the 82-inch McDonald Observatory reflector that evening, described the tail as 25° long, pointing northward into Cassiopeia. The total naked-eye magnitude of the comet was +3, and the nucleus was 6th magnitude. Besides the main tail, he saw a slender jet about four degrees long, pointing toward the sun.

At Harvard Observatory, other magnitude estimates of the total light of the comet on April 23rd were 1.9, 2.5, and 2.2, by Miss F. W. Wright, L. J. Jacchia, and J. Ashbrook, respectively.

The average of all four observations of this night is +2.4, so that Comet Arend-Roland was about 1.6 magnitudes fainter than the prediction on page 298 of the April issue.

The peculiar sunward spike, described by Dr. Van Biesbroeck and well shown in the front-cover photograph and Freeman D. Miller's picture on this page, was a widely observed temporary feature of great interest. Dr. Miller reports that two days earlier, on April 23rd, this secondary tail appeared fairly broad, pointing to the west of the line from the comet head to the sun. On the 25th, the spike was narrower and brighter, and nearly in line with the main tail. Next evening it was

The head of Comet 1956h as photographed at Mt. Stromlo, Australia, on April 11th (April 10, 19:12 Universal time), with the 26-inch Yale-Columbia refractor of 35 feet focal length. This observation was secured when the comet was in the daytime sky for the Northern Hemisphere. Mount Stromlo Observatory photograph, by K. Gottlieb and A. Przybylski.

directed slightly east of this line, the apparent clockwise rotation having continued. On the 28th, this feature was faint and stubby, pointing still farther to the east of the comet-sun line.

From these facts, Dr. Miller suggests that the "spike" may have been a flat tail, somewhat fan-shaped, and inclined slightly to the plane of the comet's orbit. When the earth was in the plane of this secondary tail on April 25th, the latter was seen edgewise as a thin, bright jet.

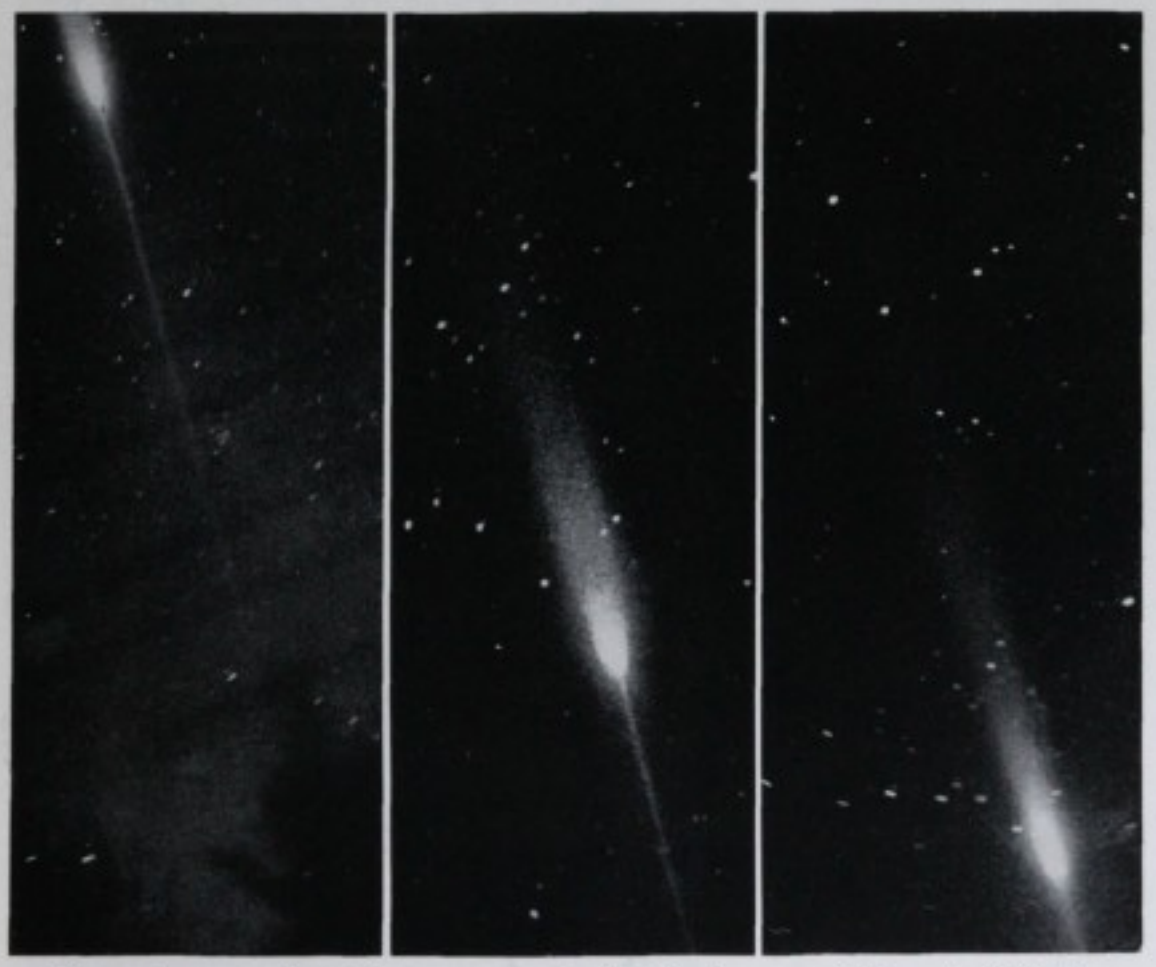
Because the main tail faded with increasing distance from the comet's head, estimates of tail length were minimum values that depended on the purity and darkness of the observer's sky. When Alan McClure took the front-cover photograph on April 24th, he could trace 30 degrees of the tail in 70-mm. binoculars, thanks to the clearness of the California mountain air. Mr. McClure, a member of the Association of Amateur Astronomers at Glendale, took his camera, guide telescope, and equatorial mounting into the mountainous region east of Mount Wilson Observatory. His clock drive was electric, with electric control in right ascension and handwheel control in declination. His camera had a ground-glass back on which the comet could be positioned directly. That Wednesday night was the first in the Los Angeles area when the comet could be seen, the previous evenings having been cloudy. The scale of Mr. McClure's picture is one inch to 1.8 degrees, corresponding to 1,750,000 miles.

At Edmonton, Alberta, the comet was first observed by Franklin Loehde on April 21st, at about 8:40 p.m. Mountain standard time. In his 6-inch reflector, the nucleus was about 10 seconds of arc in diameter. Coma and nucleus had a distinct yellowish tinge, but on the 25th they were bluish. The spike was considerably thinner and somewhat brighter on the 25th than on the 23rd. He made the following total-magnitude estimates of the comet head: April 21, 1.9; 23, 2.3; and 25, 2.8.

As this issue of *Sky and Telescope* goes to press, many observational reports by amateurs are being received, and must be held for the July issue.

During June the comet will be far too faint for observation with the unaided eye, but it will remain within reach of many amateur telescopes as it fades from about magnitude 9 to about 11. It will be a circumpolar object for observers in the north temperate zone. The following predicted right ascensions and declinations, 1950 co-ordinates, for 0^h Universal time on every 10th date, show the comet's course from Camelopardalis into Ursa Major. They are computations by the Japanese astronomer I. Hasegawa, and reprinted from page 244, March issue.

May 22, 7^h 12^m.3, +63° 15′. **June 1,** 7^h 57^m.9, +62° 07′; **June 11,** 8^h 30^m.4, +60° 54′; **June 21,** 8^h 56^m.4, +59° 49′. **July 1,** 9^h 18^m.6, +58° 54′.



Three photographs of the comet on April 25th, between 21:00 and 21:30, by Tore Sjögren, at Hovas, Sweden. He used an f/3.6 camera with a Petzval lens of 75 millimeters diameter. The exposures were each three minutes on Ilford HPS film. The first two pictures, which bring out the narrow secondary tail pointing toward the sun, were guided on the nucleus of the comet itself. In the third exposure, the guide star was Tau Persei, in order to record the utmost extent of the main tail.

In this second Portage Lake photograph by Dr. Miller, on the evening of April 28th, the comet's appearance was drastically altered. By then the narrow sunward tail had changed into a short, much fainter fan, no longer directly opposite the main tail. This half-hour exposure was on a 103a-O plate behind a light yellow filter (Schott GG5). University of Michigan Observatory photograph.

COMET AREND-ROLAND OBSERVED BY RADIO

As Comet 1956h (Arend-Roland) is the first great comet to appear since radio telescopes have come into general use, several observatories have sought to detect radio emission from this object.

The first report of success came from Brussels, Belgium, announcing that Koeckelenbergh at the Humain station observed radio noise from the comet on April 9th at a frequency of 600 megacycles (50 centimeters). The apparent extent of the comet as a radio source was eight degrees.

Fuller details are available on the observations at 11 meters (27.6 megacycles) by John D. Kraus at the Ohio State-Ohio Wesleyan Radio Observatory. Weak radio noise was first recorded on March 10th, again on the 16th with greater strength, and thereafter nearly daily. The intensity was observed to fluctuate by ±30 per cent from day to day.

Dr. Kraus reports that the center of the 11-meter radiation appeared to be in the tail of the comet, some seven million miles from the head. On April 20th and 21st, the emitting part of the tail was observed to break away, and appeared to move radially outward from the sun.

The author stands at the right in this picture of those who took part in the field work described here. Next to him, from right to left, are Margot, Marion, and Eric Rinehart; to their left is Nicholas Matalas, a graduate student in engineering at Harvard University, Robert O'Neil and Robert Olson, senior geology students at Harvard. Expedition photographs with this article were taken by Dr. Rinehart.

A Soil Survey Around the Barringer Crater

JOHN S. RINEHART
Smithsonian Astrophysical Observatory

IN THE HIGH PLATEAU of northern Arizona, about 40 miles east of Flagstaff, lies an extraordinary formation—a great pit some 600 feet deep and 4,100 feet across, with a rim rising steeply to about 160 feet above the surrounding level. D. M. Barringer in 1905 first established that this crater was of meteoritic origin. The cataclysmic impact may have occurred as long ago as 5,000 to 50,000 years, for the semiarid climate has tended to preserve the general outlines and dimensions of the crater in their original form.

In the summer of 1956 the Smithsonian Astrophysical Observatory sent an expedition to survey the surroundings of the Barringer crater. We planned to chart the distribution of the innumerable tiny meteoritic fragments that are scattered through the soil for miles around, and to study the nature of these bodies. The expedition was partly financed by the Air Force Cambridge Research Center.

During the three months the Smithsonian party was in the field, its headquarters were the buildings that once had served as the local trading post and museum, but which had been abandoned several years ago when U. S. highway 66 changed its route. Here, within six miles of the crater, we found living quarters and laboratory space.

Nearly 90 square miles were to be covered by the survey. At predetermined points, shown in the accompanying chart, soil samples were to be collected for study. Our first step, therefore, was to rediscover the bench marks that the U. S. Grazing Service had placed at all section corners in the area. These marks are on short brass-capped iron posts. Once we had recovered one such marker on the northeast rim of the crater, we could use surveying

Left: Two crew members collect a 4½-pound sample of surface soil, from which the meteoritic content will later be separated and studied.

Right: At many of the survey sites investigated, holes were dug to bedrock, to allow soil samples to be taken for each six inches of depth. To the left is one of the flagpoles erected to identify digging points. The short dark cylinder at its base carries a U. S. Grazing Service marker.

instruments to find the others. Each of these posts was then marked with a flag. The crew also located the quarter-section points.

Each day field work started early in the morning, for our rented truck provided little shelter against the heat and wind of the afternoons. After mid-July the threat of the daily thunderstorm made digging late in the day a hazardous job. The terrain was difficult; sometimes the truck bogged down in blow sand or in morasses of mud, and it was not easy to move equipment across Canyon Diablo, 50 feet deep (see center-spread photograph).

The crew took soil samples at half-mile intervals along the section lines, and at each marker flag they dug two holes 30 feet apart. The meteoritic content of the samples from two such holes, close as they were, was often very different. For a surface sample, a crew member would put a shovelful of dirt directly into a paper quart container.

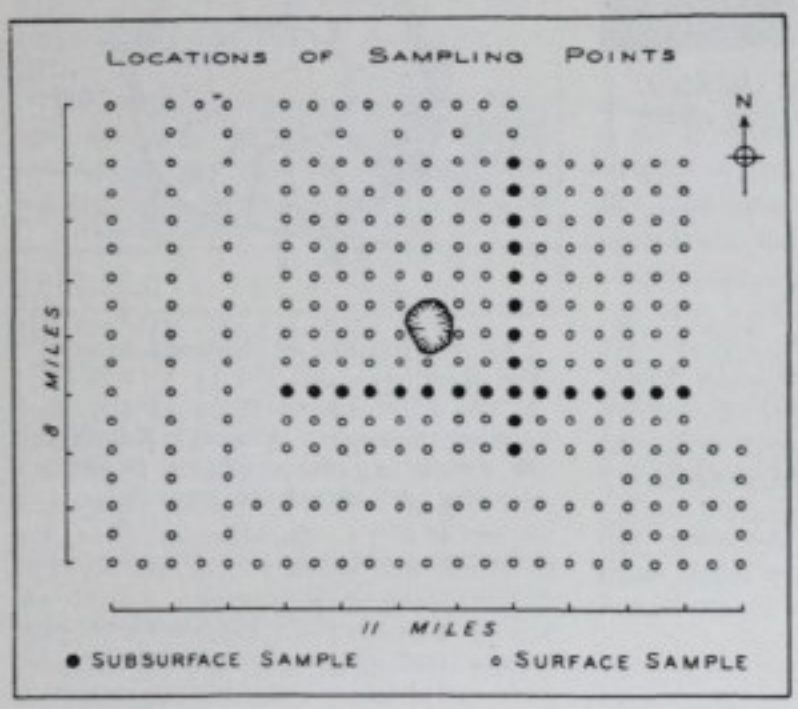
We dug some 25 holes down to bedrock by hand, in order to find the vertical distribution of the meteoritic debris. This subsurface sampling was more arduous, and not more than four holes were dug in a single day. Ordinarily, the depth to the limestone was two to four feet. From each hole the diggers took samples at four or five different levels. In a typical hole, there would be less and less meteoritic material with increasing depth, and practically none at bedrock.

The most difficult problem in collecting subsurface soil samples was to avoid contamination from surface material. This was why we had decided not to use power diggers. In our routine, the worker used pick and shovel to dig the hole to a depth of about six inches. He then laid a piece of cloth on the bottom, carefully scraped dirt from the walls of the hole onto the cloth, and put it into a paper container. This process was repeated for each additional six inches of depth.

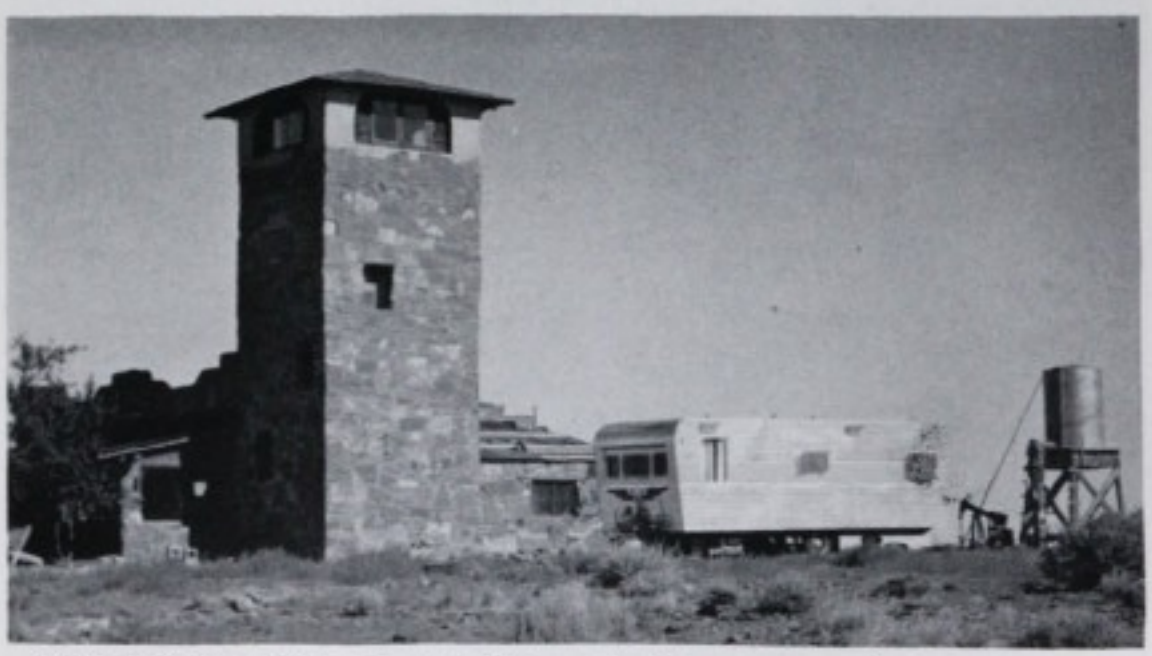
Each quart-sized paper container was labeled carefully in the field at the time it was filled, and every day the truck carried more of these cartons back to our laboratory at headquarters for processing. Each sample was sifted through a series of four standard sieves. The particles retained on the No. 10 sieve were discarded because of their coarseness. The material from the second and third sieves, U. S. No. 40 and No. 100, was preserved in labeled plastic bags; the rest was discarded. During the summer, members of our expedition thus shoveled, bagged, labeled, and processed more than a ton of dirt that was at last thrown to the Arizona winds—minus its meteoritic content.

To extract the meteoritic matter from the sifted soil, we used magnetic separators. We began the summer with one of these separators; it proved so easy to use and so efficient that the expedition or-

An aerial view of the Barringer crater from the southwest, looking toward the new museum on the northern rim. In the foreground is the "rock flour" indicated in the chart on page 368, a fine sandstone used in the manufacture of glass. This is one of several pictures taken by John Farrell, of Ft. Worth, Texas; another was published in the November, 1956, issue, page 21.



Each circle on this map shows where the Smithsonian expedition collected surface soil for study; solid dots mark locations at which the holes were dug for subsurface collecting.



This building, where the expedition made its temporary headquarters, was once the home of the American Meteorite Museum, now moved to Sedona, Arizona, 86 miles away in Oak Creek Canyon. At the right is the expedition's water tank.

In this picture of the laboratory, an expedition member is operating the sifter. A single sifting served to separate the particles, as the sieves were set one above the other, the coarsest one at the top.

dered more of them. Within a few weeks three additional magnetic separators had been built in Cambridge, Massachusetts, and shipped to Arizona and put in use.

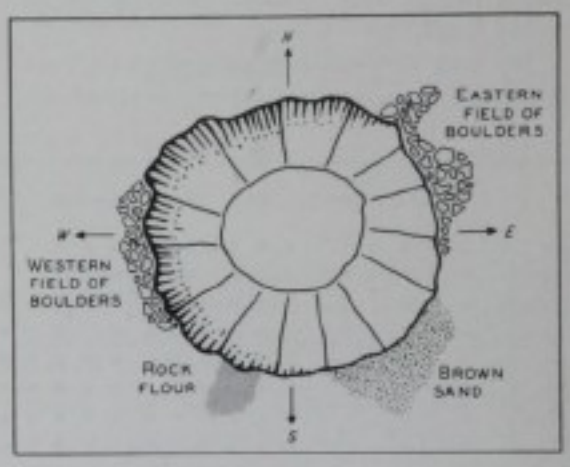
This ingenious device consisted of a vibrating hopper and a slanting trough down which the dirt moved. Above this trough were suspended three powerful Alnico magnets, and as the soil moved past, the meteoritic material flew up and adhered to the magnets. Afterward, this matter was carefully brushed into a small bottle and sealed.

The magnets collected three types of strongly magnetic material: meteoritic particles consisting mostly of nickel-iron, meteoritic iron-oxide particles, and occasional black shiny specks. The last are probably of volcanic origin. The easiest way to distinguish between these varieties is to mount the particles in plastic, and then grind the plastic so the particles are seen in cross section.

Our laboratory, where the sifter and separator were located, was a single room whose walls were lined with geological survey maps. Here there was a microscope, reagents for testing the meteoritic debris, and all the supplies necessary for casting in plastic. Accurate weighing could not be carried out here; for this, the expedition had access to the science laboratory of Arizona State College, in Flagstaff, thanks to Miss A. M. Allen.

During the course of this three-month survey, about 700 samples of material were secured from the area. A typical soil sample as brought in from the field weighed some 4½ pounds. Usually the meteoritic content was less than 0.5 per cent, but once reached 0.84 per cent.

The correlation between the finer material (size 100) and the coarser material (size 40) was good. The concentration of meteoritic fragments in size 40 was roughly three times that in size 100. In the final analysis only the quantity of size 40 material was used to estimate the total meteoritic content in a particular sample of soil.

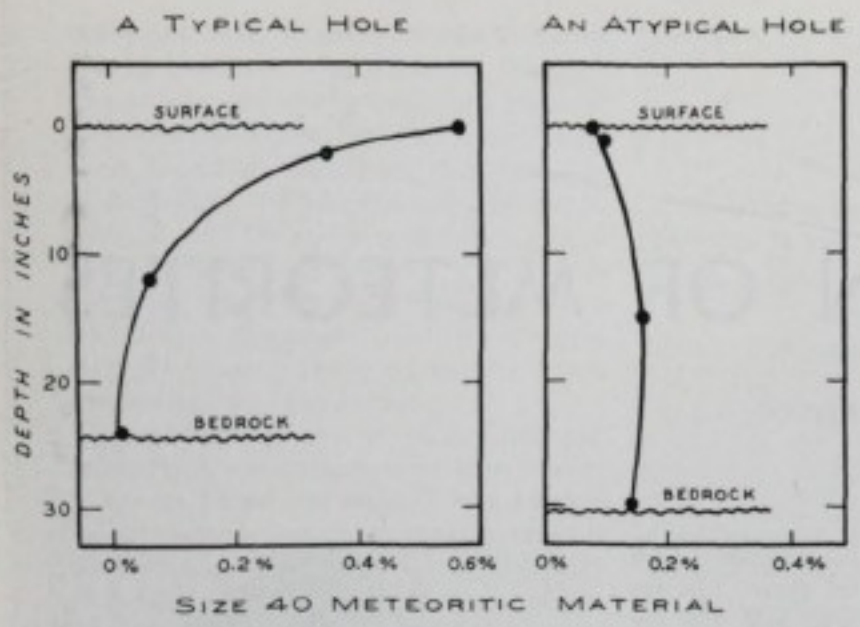


The distribution of material around the Barringer crater may be related to the direction of flight of the incoming meteorite. The rock flour can be seen along the southwest slope in the photograph on page 367.

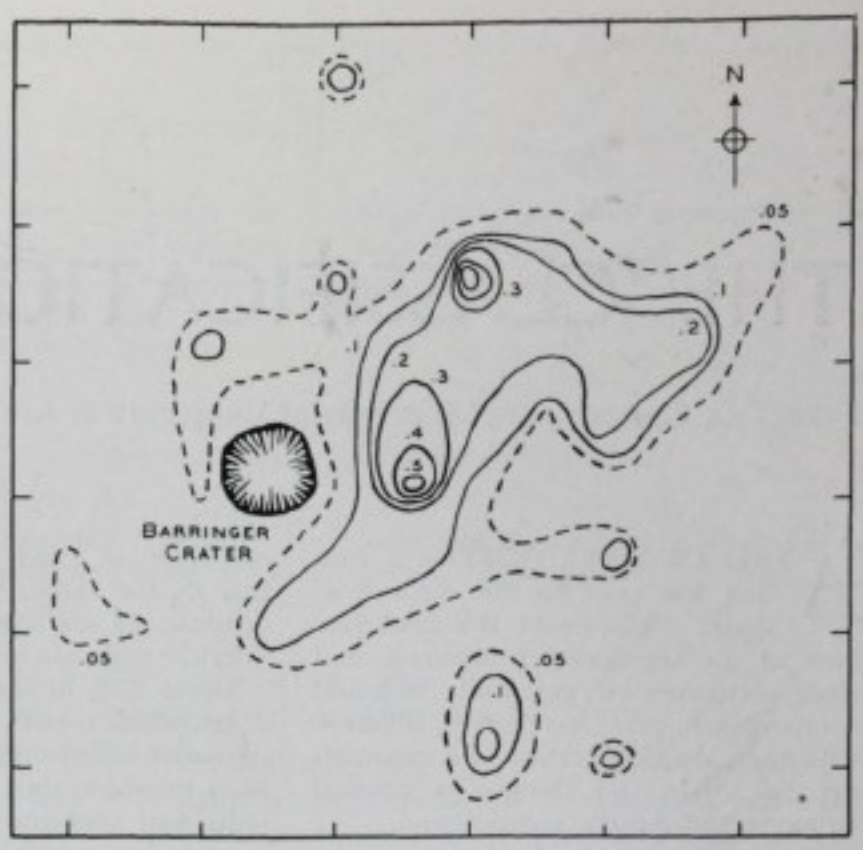
The map on page 369 shows the distribution of meteoritic debris in the region surrounding the Arizona meteorite crater, according to our survey. The lines are contours of equal abundance. Clearly, the debris is not symmetrically spread around the crater; rather it forms a definite pattern whose line of symmetry runs

Left: Margot Rinehart feeds a bagful of sifted soil into the magnetic separator. Attached to the slanting bar are three Alnico magnets which collect the meteoritic particles.

Right: The use of a cloth to avoid contamination of subsurface samples is illustrated in this picture.



Above: Subsurface samplings usually showed that meteoritic debris was most abundant near the surface, but not all holes were alike in this respect.



Right: In this map of the environs of the crater, contour lines show percentages of meteoritic matter in the soil.

roughly 15 degrees north of east. In this pattern, the map shows several localized areas particularly rich in meteoritic particles.

The piling up of material to the east, and symmetry of the pattern suggest strongly to me that the meteorite that formed the crater approached from a direction slightly to the south of west, and not nearly from the north as has been previously assumed.

Our samplings indicate that the total amount of meteoritic debris around the crater is 12,000 ordinary tons. Thus, the weight of the meteorite that produced the crater must have been at least this great. Ballistic calculations give about the same figure for the mass of a body needed to make a hole as large as the crater. This indicates that most if not all of the meteorite was broken into fine particles, and it seems doubtful that any sizable mass lies buried beneath the floor of the crater.

INCREASING THE SPEED OF LARGE TELESCOPES

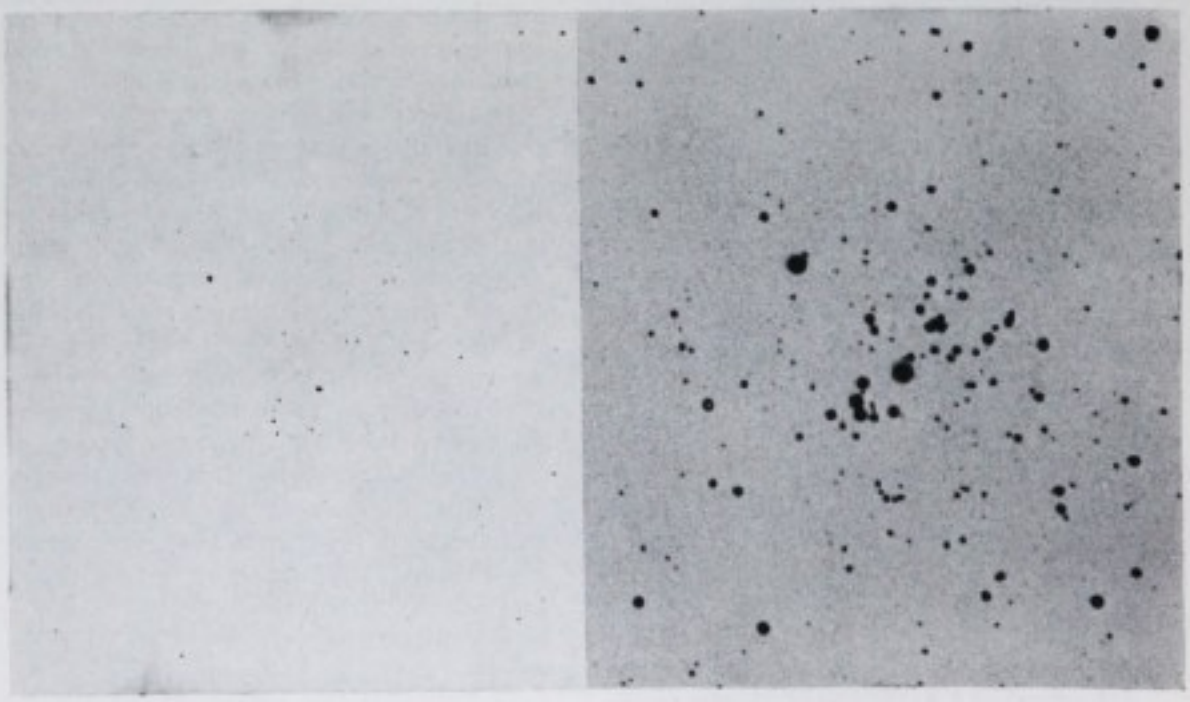
At Yerkes Observatory, A. B. Meinel has constructed a camera which can be attached to large telescopes to increase greatly their effectiveness for direct photography. This f/2 camera, designed for use at the Cassegrainian focus of the 82-inch McDonald reflector, has operated for over a year with very promising results, Dr. Meinel has reported in the November, 1956, issue of the *Astrophysical Journal*.

The camera is intended to provide both high speed and a relatively large plate scale. It utilizes the principle that the first-order optical performance of a telescope depends solely upon the initial aperture of the system and on the solid angle of the rays at the final focus. With this camera in place, the 82-inch reflector has the speed and plate scale of an f/2 telescope of 82 inches aperture. The camera uses a field lens of 6½-inch diameter, placed at the original Cassegrainian focal plane of the main telescope, followed by a four-element Tessar collimator and an f/2 Leica Summicron lens.

As used with the 82-inch telescope, this accessory device gives a field 20 minutes of arc in diameter, with almost negligible aberrations. The light beam between the collimator and camera lens is parallel for all parts of the field, so that an interference filter can be used in this position.

When the new Meinel camera is attached to the 40-inch Yerkes refractor, the effective speed is f/3, instead of the telescope's normal f/18, over a field 30 minutes of arc in diameter. The increased efficiency when the same numbers of quanta of starlight are focused in smaller images is illustrated by the accompanying pair of one-minute pictures of the same part of the Double Cluster in Perseus. The one at the right shows stars fully 2.3 magnitudes fainter. For longer exposures the gain is even greater, amounting to almost four magnitudes for half-hour photographs.

The prototype Meinel camera has been made as simple as possible, utilizing essentially standard components. Even better performance can be expected with more refined design.



Comparative one-minute exposures on the cluster h Persei with the Yerkes 40-inch refractor at effective speeds of f/18 and f/3 on Eastman 103a-G plates were taken in immediate succession and given the same development. The difference in brightness of the faintest stars on the two negatives is about eight times. This engraving is from the "Astrophysical Journal."

THE CLASSIFICATION OF METEORITES

FREDERICK C. LEONARD, *University of California at Los Angeles*

A FALLEN METEORITE is a rock that has come to the earth from space. Since a rock is a solid mixture or an aggregate of minerals, and since meteorites of practically identical compositions may have very different structures, the classification of a meteorite depends upon two things—its internal structure and mineral composition.

Meteorites are classified first under three divisions: *aerolites* (symbol AE), which are made up mainly of silicate minerals; *siderolites* (SO), which are constituted of roughly equal amounts of silicates and nickel-irons; and *siderites* (SI), which are composed largely of nickel-irons.

Each of these divisions is in turn differentiated into classes. Aerolites are either *achondrites* (A) or *chondrites* (C); siderolites are either *sideraerolites* (S) or *lithosiderites* (L); and siderites are *hexahedrites* (H), *octahedrites* (O), or *ataxites* (D). The characteristics of each of these seven classes will now be briefly considered.

The relative numbers of meteoritic falls of each class are quoted from the catalogue of 1,563 falls published last year by the author.* Of these, 945 are aerolitic, 61 are siderolitic, and 556 are sideritic, with one unclassified fall.

This four-pound stony meteorite is classified as a hypersthene-olivine chondrite. On September 29, 1938, it fell through the roof of a garage at Benld, Illinois, piercing the top and seat of an automobile inside. Field Museum photograph.

About 92% of the aerolites are chondrites, which consist of rounded grains or spherules, called chondri, and the groundmass in which they are embedded. An individual chondrus may be as large as a walnut or as small as a grain of sand. The remaining 8% of the aerolites, being devoid of chondri and having a comparatively homogeneous structure, are called achondrites.

Of the transitional division known as the siderolites, 34% are sideraerolites, which contain more silicates than nickel-iron and thus are primarily stony meteorites. The other 66%, the lithosiderites, are richer in nickel-iron than in silicates, and hence are basically nickel-iron meteorites.

Lastly, 8% of the siderites are hexahedrites, so named because they show cubic crystallization and cleavage—polished and etched sections revealing Neumann lines. About 80% of the siderites are octahedrites, which exhibit octahedral crystallization and cleavage—polished and etched sections showing Widmanstätten figures. The remaining 12% are ataxites, which are generally structureless macroscopically, the word ataxite meaning "without arrangement."

In the simplified classification developed by the author in 1948 and the years following, meteorites are finally divided into some 30 subclasses, each depending not only on the internal structure but on the mineral composition. Knowledge of the structure enables us to determine which class a meteorite belongs to, but we must know also the mineral composition in order to assign the body (or specimen) to a subclass. There are altogether 21 essential meteoritic minerals, that is, minerals that occur so plentifully in meteorites as to be utilizable for classifying them. These minerals are all either nickel-irons or silicates.

The three nickel-irons or "the trias"—the essential minerals of the siderites—are alloys chiefly of iron and nickel, each of somewhat variable composition. They are called *kamacite* (symbol i^1), *taenite* (i-), and *plessite* (i^3), the third being not technically a mineral but rather an intimate mixture of the first two on a microscopic scale.

On June 20, 1919, at 6 p.m., a stony meteorite or aerolite fell near Ridge, in St. Mary's County, Maryland. This specimen is part of a piece found by Capt. John Forrest; it weighs 24¼ grams and has a specific gravity of 3.24. This chondrite is one of the two falls that Dr. Leonard places in the subclass $Cp^1o(g)$. Maryland Academy of Sciences photograph.

The essential minerals of the aerolites belong to four groups:

1. *Olivine* (o), a magnesium-iron silicate.

2. The 10 *pyroxenes*, which consist of *enstatite* (p^1), *bronzite* (p^2), *hypersthene* (p^3), *clinoenstatite* ($p^{1'}$), *clinobronzite* ($p^{2'}$), and *clinohypersthene* ($p^{3'}$), all magnesium-iron silicates; *pigeonite* (p^5), a magnesium-iron and calcium silicate; *diopside* (p^6), a calcium-magnesium silicate; *hedenbergite* (p^7), a calcium-iron silicate; and *augite* (p^8), a complex silicate of calcium, magnesium, iron, and aluminum.

3. The six *plagioclase feldspars*, which are *albite* (f^1), *oligoclase* (f^2), *andesine* (f^3), *labradorite* (f^4), *bytownite* (f^5), and *anorthite* (f^6), all sodium-aluminum and calcium-aluminum silicates of various compositions.

4. The silica *tridymite* (s'), which is a form of silicon dioxide.

Moreover, because of its abundance in

**A Classificational Catalog of the Meteoritic Falls of the World*, Vol. 2, No. 1, of the University of California *Publications in Astronomy*, 1956. The writer's system of classification is described in detail there and in an article in *Meteoritics*, *1*, 150-168, 1954.

many aerolites, *glass* (g) may be included among their essential minerals, although like plessite it is not technically a mineral. And the three principal "accessory" minerals found in meteorites (for example, as inclusions in siderites) also should be mentioned. These are *cohenite*, a nickel-iron carbide; *schreibersite* (called also rhabdite when in needlelike form), a nickel-iron phosphide; and *troilite* (the terrestrial variety being commonly termed pyrrhotite), an iron sulfide.

In addition to the two dozen minerals (plus glass) just named, more than a score of others have been identified in meteorites as being accessory minerals, some only as "trace" or "doubtful" constituents. Among these accessory minerals is the element carbon, in no less than three distinct forms: graphite (including cliftonite), amorphous carbon, and diamond (usually as black diamond, or carbonado).

As has been stated, when the mineral composition as well as the internal structure of a meteorite has been ascertained, it can be assigned to one of the 30 subclasses in the simplified classification. Their symbols, given in the accompanying table, are easily read. For example, if it is known that the essential minerals of an achondrite are hypersthene (p^3), clinohypersthene ($p^{3'}$), and anorthite (f^6), it is an $Ap^3p^{3'}f^6$ meteorite, the mineral symbols being appended in order of decreasing abundance of the corresponding minerals in the specimen. The names, however, are read in the opposite order, as anorthite-clinohypersthene-hypersthene achondrite.

Since siderites are all nickel-irons, the two subclasses of hexahedrites (which have practically identical compositions) are distinguished by the qualifying symbols (n) for normal or nongranular and (a) for granular. The five subclasses of octahedrites are distinguished by qualifiers that specify the widths of the Widmanstätten bands: (gg), (g), (m), (f), and (ff), standing for coarsest, coarse, medium, fine, and finest, respectively. The three subclasses of ataxites are differentiated by the symbols D^{II} (nickel-poor or hexahedritic ataxite), D^{0} (intermediate or octahedritic ataxite), and D^{I} (nickel-rich or primary ataxite). These superscripts indicate that D^{II} has practically the same mineral composition as the hexahedrites, that D^{0} has the same *range* of composition as the octahedrites, and that D^{I} is richer in nickel than is any other subclass of meteorite. The last-named subclass is the fundamental type of ataxite, the other two kinds being probably derivatives (due to preterrestrial heating) of hexahedrites and octahedrites, respectively.

Various other qualifiers may be used for more detailed descriptions of aerolites (especially chondrites). Such symbols are: (b) brecciated, (c) spherulitic, (g) gray, (i) intermediate, (k) crystalline, (r) car-

The Leonard Classification of Meteorites

AEROLITES (AE)
(Stones; sp. gr. about 3.0 to 3.5)

Achondrites (A)

Homogeneous, sometimes with nickel-iron particles. A^1, calcium-rich; A^2, calcium-poor.

11 subclasses: Ap^1—Ap^2p^3o—Ap^2f^6—Ap^2f^0
$Ap^1p^{3'}f^6$—Ap^1—Ap^3o
$Ap^{2'}o$—Ap^3o—$Ap^3p^{3'}$—Ao

Chondrites (C)

Rounded grains in a groundmass; often with nickel-iron particles.

5 subclasses: $Cp^3p^{3'}o$—$Cp^2p^{3'}o$
Cp^3o—Cp^1—Co

SIDEROLITES (SO)
(Stony-irons; sp. gr. about 5.5 to 6.0)

Sideraerolites (S)

Predominantly silicate phase (generally achondritic), with nickel-iron phase.

2 subclasses: $Sp^3p^{3'}f^6o$—Sp^3o

Lithosiderites (L)

Nickel-iron matrix filled with olivine (all but one are Lo).

2 subclasses: Lp^3s'—Lo

SIDERITES (SI)
(Irons; sp. gr. about 7.5 to 8.0)

Hexahedrites (H)

Cubic crystallization and cleavage; Neumann lines.

2 subclasses: H (n)—H (a)

Octahedrites (O)

Octahedral crystallization; Widmanstätten bands.

5 subclasses: O (gg)—O (g)
O (m)—O (f)—O (ff)

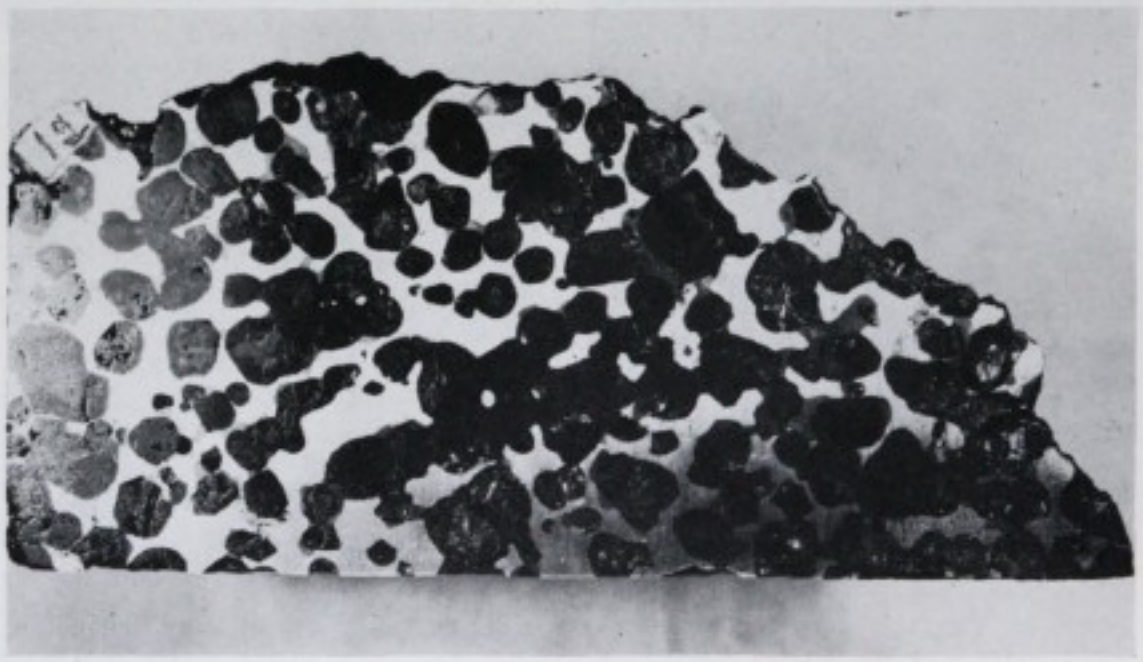
Ataxites (D)

Essentially structureless masses of metal.

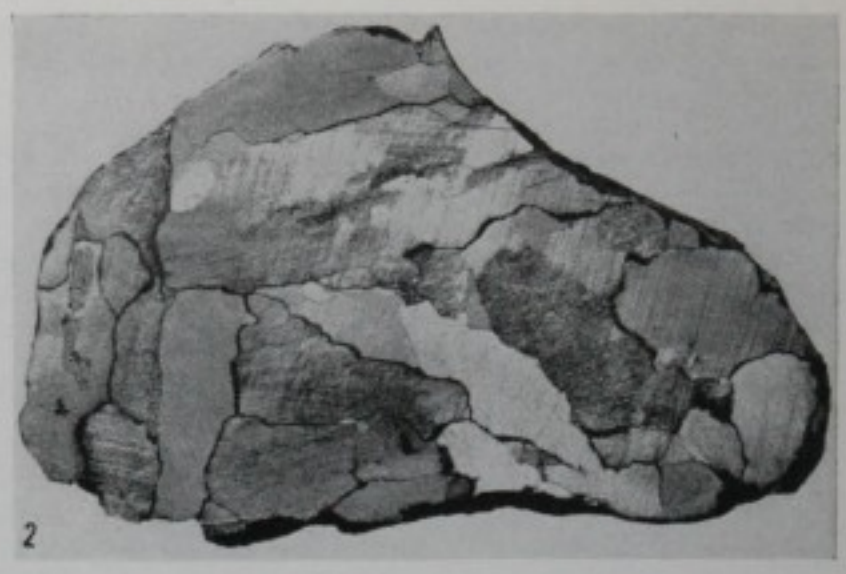
3 subclasses: D^{II}—D^{0}—D^{I}

The values of the specific gravity (sp. gr.) given for the respective divisions may have to be revised in the future.

The Arispe, Mexico, iron meteorite is a coarsest octahedrite, showing very broad Widmanstätten figures. The bands of kamacite average three or four millimeters in width. This meteorite, which contains 7.0 per cent nickel, was found in 1896. Photograph from U. S. National Museum Bulletin No. 184, by Stuart H. Perry.



The Springwater, Saskatchewan, siderolite is an olivine lithosiderite (Lo) in Dr. Leonard's classification. In this polished slab, the darker portions are brown and amber crystals of olivine; the lighter parts are silvery-appearing nickel-iron. Three meteorites from the Springwater fall have been recovered, weighing a total of 150 pounds.



Left: This siderite is a normal hexahedrite, part of a two-ton fall from Coahuila, Mexico, sometime before 1837. Note the fine grid of Neumann lines. Right: The granular hexahedrite shown in cross section here was found in the Sandia Mountains, New Mexico, in 1925. Both of these specimens are at the U. S. National Museum, from whose Bulletin No. 184, "The Metallography of Meteoric Iron," 1944, the pictures on this page are reproduced.

bonaceous, (s) black, (v) veined, and (w) white. These letters are added in parentheses to the symbol for the aerolitic class or subclass, of which, however, a qualifier is never an integral part.

When a chondrite is broken open, we see the chondri, which have ordinarily about the same mineral composition as the groundmass; these features are most conspicuous on a plane, polished surface, and are often easily detected with the aid of a magnifying glass. Most chondrites and many achondrites contain grains of nickel-iron scattered freely throughout them. The chondri have no known analogues in terrestrial rocks, and, together with the particles of free metal, are among the most trustworthy criteria for distinguishing the vast majority of aerolites from earthly stones.

The Hoba, South-West Africa, iron is one of the two largest individual meteorites known. It is a nickel-rich ataxite, with cobalt and nickel together amounting to 17 per cent. This photomicrograph, about 100x, shows the absence of structure in the groundmass; a needle of kamacite appears nearly white in the picture.

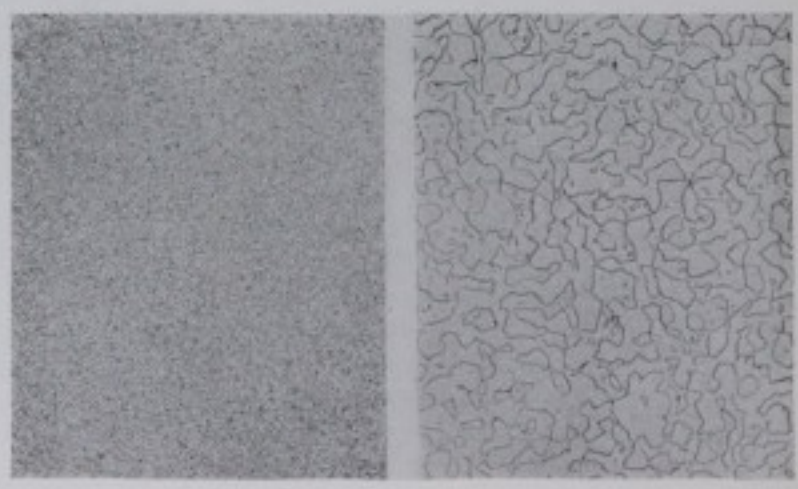
All but one of the 35 lithosiderites on record are olivine lithosiderites (Lo). When one of these stony-iron meteorites is sectioned, it is found to consist of a mesh or spongelike matrix of nickel-iron, the interstices of which are filled with honey-colored or dark-brown olivine. This structure also has no terrestrial counterpart, and so serves as an invaluable criterion for identification.

When an octahedrite is cut open, and the freshly exposed surface is polished and etched by means of a dilute (about 6%) solution of nitric acid or some other etching agent, a remarkable pattern of crystallization formations is revealed. These are called Widmanstätten figures, in honor of an Austrian scientist who, in 1808, was one of the first persons to observe them. The plates or laminae that are responsible for this effect lie parallel to the four pairs of faces of an octahedron, and so present, in cross section, the appearance of a latticework.

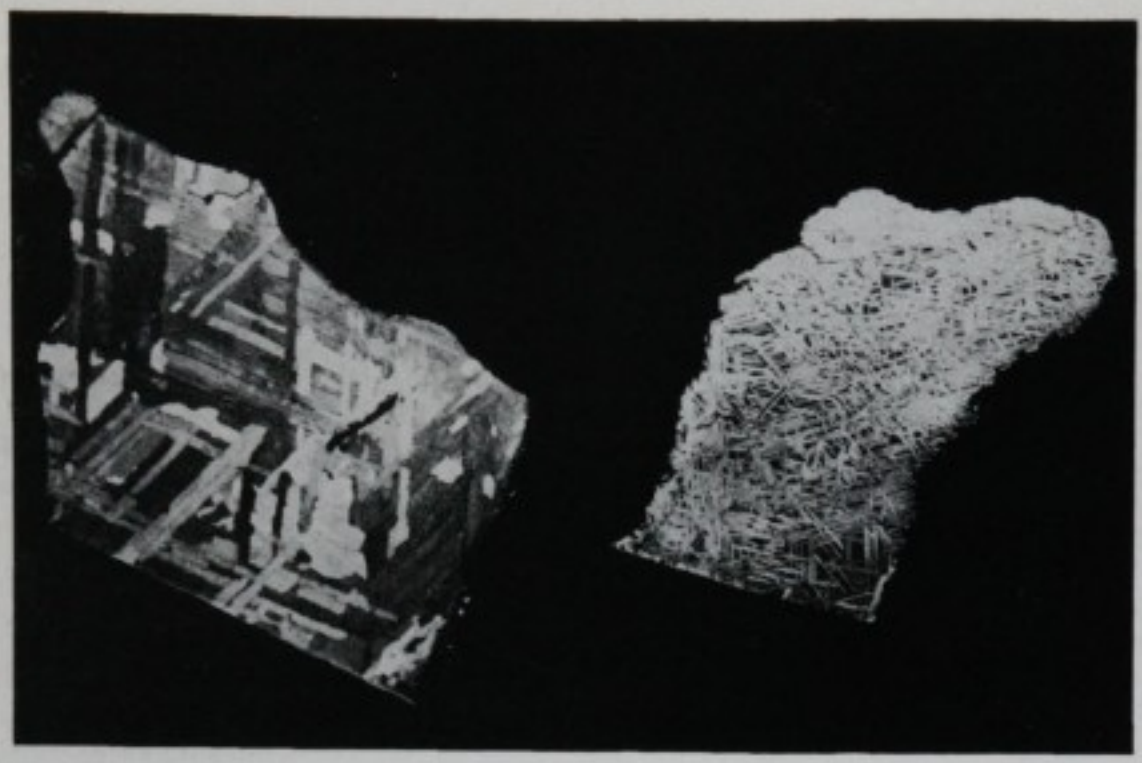
A typical Widmanstätten band consists of a central portion of kamacite, flanked on each side by a comparatively thin border of taenite. The spaces that are inclosed within the intersecting bands are filled with plessite, which, as has been mentioned, is really a microscopic intergrowth of kamacite and taenite. Since Widmanstätten figures occur exclusively in four-fifths of all the nickel-iron meteorites (the octahedrites), and since, at least on a macroscopic scale, these figures have never been duplicated in the laboratory, any specimen of iron that shows them is unquestionably of cosmic origin. Hence, these bands serve as an infallible criterion for the identification of 80% of the siderites, just as do the chondri and the bits of free metal for over 90% of the aerolites.

Of the seven classes of meteorites, the achondrites and the ataxites are admittedly the most difficult to identify merely by their internal appearance—the achondrites because they most closely resemble certain earthly stones, the ataxites because they are essentially structureless masses of metal. Even the hexahedrites, with their cubic crystallization and cleavage, exhibit characteristic features on etching known as Neumann lines. These lines, however, are not nearly so noticeable, as a rule, as are the Widmanstätten figures of the octahedrites. Of the two classes of siderolites, the sideraerolites contain moderate-sized grains or nodules of nickel-iron that are separated from one another in plane sections, whereas the lithosiderites have an abundance of nickel-iron that is continuous both throughout the mass and on sections, and that forms, in nearly every case, a spongelike matrix, the interstices of which are filled with olivine, as already stated.

Every kind of meteoritic iron is of course an alloy, or a combination of two or three alloys, of iron, nickel, and cobalt,



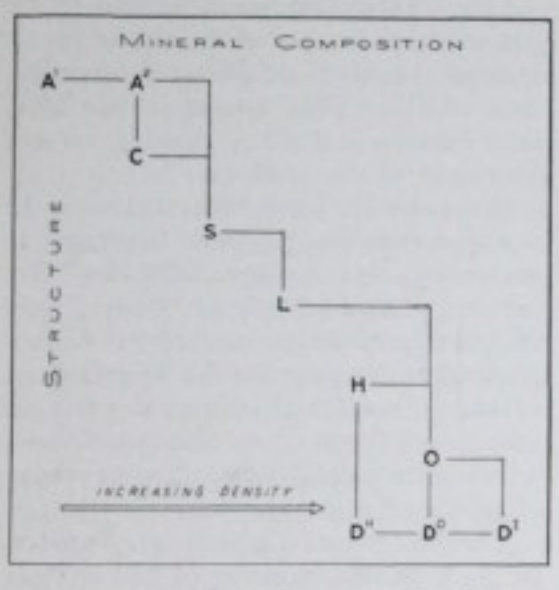
Two views of the same polished and etched cross section of the Ternera meteorite, found in Chile before 1891, enlarged about 50 and 500 times natural size. This is a nickel-rich ataxite, with a nickel-cobalt content of 17.8 per cent.



The Henbury, Australia, siderite (left) is a medium octahedrite found in 1931. Note the much narrower Widmanstätten bands in the Carlton, Texas, iron (right), a fine octahedrite that was found in 1887.

in which nickel is nearly always a poor second to iron, and cobalt is always a poor second to nickel. Class H and subclass D^{II}, both of which are made up largely of kamacite, contain about 94% iron and 6% nickel. Class O and subclass D^{O}, which are composed of all three members of the trias—kamacite, taenite, and plessite—have from 94% to 85% iron and from 6% to 15% nickel. The nickel-rich or primary ataxites, D^{I}, made up of plessite and taenite, possess ordinarily from 85% to 70% iron and from 15% to 30% nickel.

Furthermore, the width of the Widmanstätten bands, which varies from less than 0.2 to more than 2.5 millimeters, is normally a very sensitive indicator of the percentage of nickel present in an octahedrite. Those with the broadest bands, the coarsest octahedrites, O(gg), have the lowest percentage of nickel (about 6%); and those with the narrowest bands, the finest octahedrites, O(ff), have the highest, about 15% nickel.



The relationships between the classes of meteorites in the simplified system of classification are indicated here. Meteorites on the same horizontal line have the same structure but different mineral compositions; vertical displacement means difference in structure, with composition unchanged.

The relations existing among the several classes of meteorites are most effectively brought out by means of the classificational sequence with its linkage, shown in the accompanying diagram. All the symbols in this chart have already been defined, except A^1 and A^2, which represent the calcium-rich and calcium-poor achondrites, respectively. (Subclass A^1 is made up principally of calcic pyroxenes, p^5 to p^8, and plagioclase feldspar, f^6 or f^8, whereas A^2 is composed mainly of non-calcic pyroxenes, p^1 to $p^{3'}$, and/or olivine, o, as are likewise the chondrites and the silicate phase of the sideraerolites and of the lithosiderites.)

In this graphical arrangement, mineral composition varies horizontally, whereas internal structure changes vertically, that is, from class to class. Density (specific gravity) increases from left to right. Therefore, those classes whose symbols are vertically aligned (such as A^2 and C, H and D^{II}) have practically the same composition and density, but different structures. Among other things, the device shows plainly the relation existing between the calcium-poor achondrites, A^2, and the sideraerolites, S, of which the silicate phase is generally achondritic, as well as that between the lithosiderites, L, and the octahedrites, O.

If the classificational sequence has any genetic significance, it probably represents the order, from surface to center, in which were arranged the materials that constituted the "meteorite planet," that hypothetical body whose breakup in the remote past—as some investigators have supposed—may have been responsible for the origin of fallen meteorites.

NEW BRIGHT VARIABLES

The brightest star in the constellation of Capricornus is an eclipsing variable of the Algol type, according to observations by O. J. Eggen reported in the December, 1956, *Publications* of the Astronomical Society of the Pacific. For his work on this star and another new variable, Delta Delphini, he used a 1P21 photomultiplier and a yellow filter attached to the 12-inch refractor of Lick Observatory.

Delta Capricorni has long been known as a single-line spectroscopic binary, with a period of 1.02275 days. In the eclipse observed by Dr. Eggen, the brightness change was about 0.16 magnitude. At a distance of about 50 light-years from us, Delta Capricorni is one of the nearest eclipsing binary systems, and warrants further study.

The period of light variation of Delta Delphini is somewhat longer than three hours, the change in brightness being less than 0.1 magnitude. The radial velocity of this metallic-line star had already been found to change over a range of about 15 kilometers per second, but no period had been determined. Dr. Eggen points out that this new variable probably belongs to the group of which Delta Scuti is the prototype.

FIRST SATELLITE FLYBY

The first simulated satellite, an Air Force F86D jet fighter, flew over three manned optical-tracking stations in the Washington, D. C., area on April 27th. Operation *Jetallite*, the first such visual satellite observing test, was conducted with the co-operation of the U. S. Air Force, under the supervision of Col. Owen F. Clarke, MOONWATCH liaison officer.

The plane flew at an altitude of 25,000 feet, 425 miles per hour, bearing only a tiny light to give to ground observers the appearance of a 5th-magnitude star. This is the satellite's probable maximum brightness when launched during the International Geophysical Year. Traveling on west-to-east courses, the plane crossed stations at Springfield and Ft. Belvoir, Virginia, and Silver Spring, Maryland, several times that evening.

NSF RESEARCH GRANTS

Research proposals to be considered at the August and January meetings of the advisory panel for astronomy of the National Science Foundation should be submitted to the foundation by July 1st and November 15th, respectively. No formal application blanks are needed, but a pamphlet, obtainable from the Program Director for Astronomy, National Science Foundation, Washington 25, D. C., outlines the information required.

CORRECTION

On page 266 of the April issue, in the seventh line of the second column, for 13 millimeters read 3 millimeters.

NEWS NOTES

SUPERNOVA IN URSA MAJOR

On a photograph taken March 1st, Prof. M. Schürer, Berne, Switzerland, discovered a 14th-magnitude supernova in the bright spiral galaxy NGC 2841 in Ursa Major. It was soon confirmed at Steward Observatory, Tucson, Arizona, and at Sonneberg Observatory, in East Germany.

The supernova was still of about the same brightness on the evening of March 5th, when this picture was taken with the 69-inch telescope at Perkins Observatory, Delaware, Ohio. Dr. Sidney van den Bergh writes that the negative was made on Eastman 103a-O emulsion behind a blue filter.

During the following weeks the new object faded, and was observed on March 20th as magnitude 14.6 at Skalnate Pleso Observatory, Czechoslovakia, and as 15.0 at Sonneberg. The 1950 position of NGC 2841 is right ascension $9^h\ 18^m.6$, declination $+51°\ 12'$.

In this Perkins Observatory photograph of the NGC 2841, the supernova is about half an inch (two minutes of arc) to the northwest (below and left) of the galaxy's nucleus. The supernova is just above the brightest foreground star in the field.

SYMPOSIUM AT ANN ARBOR

A symposium on stellar evolution and the abundance of the elements, sponsored jointly by the departments of astronomy and physics of the University of Michigan, is to be held at Ann Arbor from June 24th through July 12th. During the first week, Prof. W. A. Fowler, California Institute of Technology, will give five lectures on the origin of the elements.

The second week will be devoted to conferences and informal lectures. Among the conference speakers will be A. G. W. Cameron, Chalk River Project; J. L. Greenstein, California Institute of Technology; L. G. Henyey, University of California; M. Schwarzschild, Princeton University; and Hans Suess, University of California.

Information about attendance and participation in the symposium may be obtained from the Department of Physics, University of Michigan, Ann Arbor, Mich.

ORIGIN OF TEKTITES

For many years the origin of tektites has remained a puzzle. Usually these small glassy bodies, found widely distributed over the earth, are regarded as of extraterrestrial origin. Their surfaces show flow patterns that indicate they once traveled at high speed through the earth's atmosphere. But in chemical composition they resemble sedimentary rocks, except that they contain no water.

The University of Chicago scientist, Harold C. Urey, writes in the March 16, 1957, issue of *Nature* that the geographical distribution of tektites does not fit the idea that they are the fragments of a single mass of glassy material striking the earth. And on the other hand, if the tektites arrived in a swarm compact enough not to fall on all parts of the earth, they would have covered such places as southern Australia (where they are chiefly found) to a depth of several inches!

In view of the failure of the more conservative proposals, Dr. Urey suggests that tektites may be the *by-products* of a direct collision between the earth and the nucleus of a comet. At the earth's distance from the sun, the kinetic energy of a cometary nucleus is roughly equivalent to half a million hydrogen bombs. The explosion following the collision would melt sedimentary rocks and scatter them over a wide area.

Tektites are frequently shaped like buttons or lenses bearing flanges. These australites are the variety that is found in Australia, where they are estimated to number several million.

IN THE CURRENT JOURNALS

FALL OF PARITY, by L. S. Rodberg and V. F. Weisskopf, *Science*, April 5, 1957. "Before describing the experiments themselves, we will discuss the basic principle which is attacked by their results. It is the *principle of parity*. This principle can be stated in the following form: any process which occurs in nature can also occur as it is seen reflected in a mirror. Thus nature is mirror-symmetric. The mirror image of any object is also a possible object in nature; the motion of any object as seen in a mirror is also a motion which would be permitted by the laws of nature."

OPTICAL PROBLEMS OF THE SATELLITE, by R. Tousey, *Journal* of the Optical Society of America, April, 1957. "Some of the optical problems connected with an artificial earth satellite are: visibility, the photographic determination of the precise orbit, and the temperature that the satellite will reach through radiation exchange. . . . One of the first experiments to be flown will be the monitoring of the Lyman alpha line radiation of hydrogen emitted by the sun and the measurement of intensity variations associated with solar flares."

SUN CLOUDS AND RAIN CLOUDS, by Walter Orr Roberts, *Scientific American*, April, 1957. "Collisions of the earth with clouds of corpuscles from the sun are not unusual: on the average we encounter such a cloud about once a month. But they have recently taken on a new interest because of evidence that the corpuscular blasts have an impact on our weather."

ASTRONOMICAL SOCIETY OF THE PACIFIC

Lowell Observatory will be host to the Astronomical Society of the Pacific for its summer meeting at Flagstaff, Arizona, June 17-19. The International Mars Committee will hold a meeting on the afternoon of the final day.

On Tuesday, June 18th, there will be a symposium on problems common to astronomy and biology, with Dr. Hubertus Strughold, U. S. Air Force School of Aviation Medicine, as moderator. It is planned to consider the biological effects of cosmic radiation, biological processes in a simulated Martian atmosphere, and astronomical applications of recent studies of color and night vision.

The Bruce medal will be presented to Dr. I. S. Bowen, director of Mount Wilson and Palomar Observatories, at the society dinner. Also scheduled are visits to the American Meteorite Museum, the U. S. Naval Observatory's Flagstaff station, the Atmospheric Research Observatory of Arizona State College, and Barringer crater.

The Fundamental Particles of Physics

ARTHUR H. SNELL, *Oak Ridge National Laboratory*

The Sigma Xi quarterly, *American Scientist*, in its January, 1957, issue, carried an article entitled "A Survey of the Particles of Physics," by Arthur H. Snell, who is director of the physics division of the Oak Ridge National Laboratory. This summary of the state of particle physics in late 1956 gives an unusually clear picture of developments that will have increasing influence in coming years on astronomers' interpretations of the universe.

With the permission of the editors of *American Scientist*, the following portions of Dr. Snell's article are reprinted here, as being of particular interest to readers of *Sky and Telescope*, and the table of fundamental particles on page 376 is reproduced directly from the original.

"THE present situation in the physics of fundamental particles is both unprecedented and exciting. Unsuspected new particles are being found, and new properties of old ones, with a rapidity that has pushed experimentation far ahead of theory, and physicists are faced with a complicated state of affairs that invokes a sense of frustration. Their experience and instincts tell them that there *must* be some organization underlying the empirical situation, but they have not yet been able to put a finger on a comprehensive theory. A brief survey such as this must perforce emphasize the phenomenological, but it may serve a purpose if it conveys to non-physicists a share of the mystification that pervades the subject in the current state of knowledge. . . .

"For the purpose of this article we need to recapitulate one important aspect of the Dirac theory of electrons, because it introduced the concept of *anti-particles*. Electrons have spin or intrinsic angular momentum, of $\frac{1}{2}$ in units of Planck's constant h divided by 2π. As such, they obey the Pauli exclusion principle, which, as you will recall, states that two or more such particles cannot occupy the same state as described by a set of quantum numbers. If you have many particles, you have to stack them up in a series of energy states—a situation familiar to all of us in the structure of the electron shells of atoms. Dirac's theory led logically to a situation that seemed most implausible in terms of everyday experience, namely, that although the electrons that we ordinarily see around us are those in positive energy states, they are supplemented by a population of electrons in negative energy states, or, if you like, electrons of negative mass. All such states of negative energy are normally filled. When energy is supplied to one of these electrons in sufficient amount, by collision with a photon, it can be promoted to a state of positive energy, or positive mass, and so be susceptible to observation. In doing so it will perforce leave a hole in the population from which it came, and this hole will come to our awareness as a positive electron. Thus positive and negative electrons would be created simultaneously and in pairs, and the energy required of the photon would be equivalent to the rest mass of the two taken together. It is common knowledge now that the prediction of positive electrons was confirmed by their discovery in 1932, and that pair creation and the inverse process in which an ordinary electron drops into a hole, leading to the annihilation of both itself and the associated positron, are found to take place in close accordance with the hole theory. Subsequent restatements of the hole theory have made it easier to accept, but around 1930 the only other particle known to have spin $\frac{1}{2}$ was the proton, and so there arose the question 'do anti-protons (negative protons) exist?', and this remained a challenging problem that has been answered only within the last year or so.

"The well-known creation of electrons in beta radioactivity is another of their many properties, and one that is intimately connected with their role as an elementary particle. They do not exist inside nuclei, but can be created, simultaneously with neutrinos, when such a creation is energetically favorable to the nucleus. There seems to be no difference between the electrons born of beta radioactivity and those which form the exterior shrouds of atoms, govern chemical combination, account for the conduction of electricity, and ooze out of the surface of hot metals.

"The *neutrino* is perhaps the most peculiar of the so-called 'elementary' particles. It appears to be a masterpiece of zeroness. It has zero charge, its rest mass is experimentally known to be less than a thousandth of that of the electron and is commonly supposed to be zero, and its magnetic moment has been shown to be less than 10^{-7} that of the electron and also is commonly supposed to be zero. It was conceived in 1931 as an undetected third particle which would account for the apparent lack of conservation of energy in beta decay, and at first it looked like an arbitrary and artificial invention. Gradually, however, it began to make more and more sense and to fulfill theoretical need in other ways. Sensitive experiments were devised to look for the slight recoil that the departure of a neutrino would give to the parent atom, and these experiments became more and more convincing as technique improved. . . .

"The zeroness of neutrinos makes them hard to detect in the free state. It is amusing to reflect that the radioactivity of the thermonuclear processes in the sun produces them so copiously that some 10^{10} of them pass through each square centimeter of the earth's surface per second, and yet all but a few individuals skid through the earth without an atomic or nuclear impact. In fact, if the entire space between earth and sun were filled with solid matter, the neutrinos would slip through quite happily. It has been customary to call them 'elusive.' In view of this the recent detection of the free (anti) neutrino in the Los Alamos experiment, in an apparatus of finite size, is manifestly an experimental triumph. It was made possible by three developments in the experimental arts: the nuclear reactor to provide an intense terrestrial (anti) neutrino source, scintillation spectrometry to provide an energy-sensitive detector with considerable stopping power, and electronic circuitry to detect time-related events within intervals of microseconds. The description of the experiment has been published elsewhere; suffice it to say here that the observation of (anti) neutrino captures to the extent of about 1 per hour marks the culmination of the history of the neutrinos from a necessary

THE PARTICLES OF PHYSICS—1956

Mass in Units of 9.1085 × 10^{-28} g.	*Generic Name*	*Name*	*Symbol*	*Charge in Units of 4.80 × 10^{-10} esu*	*Magnetic Moment*	*Spin*	*Parity*	*Lifetime in Free Space (sec.)*	*Decay Scheme*	*Energy Release Mev*
0		Photon	γ	0	0	1	even	stable	—	—
0	Leptons	Neutrino	ν	0		½	even	stable?	—	—
0		Antineutrino	$\bar{\nu}$	0	<10^{-7} Bohr magneton	½	even	stable?	—	—
1		Electron	e^-	−1	1.001146	½	even	stable	—	—
1		Positron	e^+	+1		½	even	stable	—	—
	L-Mesons									
206.9	μ-mesons	Negative muon	μ^-	−1		½	even	2.15×10^{-6}	$e^- + \nu + \nu$	105.2
"		Positive muon	μ^+	+1		½	even	"	$e^+ + \nu + \nu$	105.2
264.5	π-mesons	Neutral pion	π^0	0		0	odd	5×10^{-15}	2γ, $\gamma + e^+ + e^-$	135.1
273.3		Negative pion	π^-	−1		0	odd		$\mu^- + \nu$	33.9
"		Positive pion	π^+	+1		0	odd	2.53×10^{-8}	$\mu^+ + \nu$	33.9
966	K-Mesons	τ-meson	τ^-	−1		integer	odd	5×10^{-9}	$\pi^- + \pi^+ + \pi^-$	73.1
"		"	τ^+	+1		"	odd	"	$\pi^+ + \pi^+ + \pi^-$	"
"		θ-meson	θ^0	0		"		8×10^{-11}	$\pi^+ + \pi^-$	214
"		$K\pi_3$ or τ	$K\pi_3$	+1		"		5×10^{-9}	$\pi^+ + \pi^0 + \pi^0$	81.8
"		" " "	"	−1		"		"	$\pi^- + \pi^0 + \pi^0$	81.8
		$K\pi_2$ or χ	$K\pi_2$	+1		integer		$1\text{-}10 \times 10^{-9}$	$\pi^+ + \pi^0$	206–218
"		" " "	"	−1		"		"	$\pi^- + \pi^0$	206–218
"		$K\mu_2$	$K\mu_2$	+1		"		8.7×10^{-9}	$\mu^+ + \nu$	
"		$K\mu_3$	$K\mu_3$	?		"		?	μ + 2 neutrals	
"		Ke_3	Ke_3	+1(−1?)		?	?		e + 2 neutrals	
1835	Nucleons	Proton	p	+1	2.7896	½	even	stable	—	—
1835		Antiproton	$\bar{p}$	−1		½*	even*		—	
1837		Neutron	n	0	−1.9130	½	even	1020	$p + e + \nu$	0.78
1837		Antineutron	$\bar{n}$	0		½*	even*		—	—
2181	Hyperons	Λ^0 (old V_1^0)	Λ^0	0		½		3.5×10^{-10}	$p + \pi^-$ or $n + \pi^0$	40
2327		Σ^+	Σ^+	+1		½		0.5×10^{-10}	$p + \pi^0$ or $n + \pi^+$	116or 111
2327		Σ^-	Σ^-	−1		½			$n + \pi^-$	111
2583		Cascade particle	Ξ^-	−1		½		$\sim 1 \times 10^{-10}$	$\Lambda^0 + \pi^-$	67

* Presumed but not measured.

concept to an experimentally-established reality.

"The distinction in nomenclature that we have just used between the neutrino and the antineutrino may be an idle one,* but it probably is not. It stems from the supposition that neutrinos belong to the family of Dirac particles, for angular momentum balances in nuclear reactions show that the neutrinos must have spin ½, and that particle-antiparticle pairs probably exist. If the rest mass is truly zero, then no energy at all would be required to create a neutrino-antineutrino pair; conversely, no energy would be released in neutrino-antineutrino annihilation. Thus a direct test of a hole theory for neutrinos is impossible in our present state of knowledge. There are, however, two indirect ways in which an experimental answer may be given to the alternatives: are the neutrino and the antineutrino the same particle, or do they in truth form a particle-antiparticle pair? The first kind of experiment arises from a classic suggestion relating to double beta decay. This would be a rare kind of radioactive disintegration in which two electrons are simultaneously emitted from a nucleus, so that the latter changes from atomic number Z to Z + 2. The rareness of the event depends upon what happens to the associated neutrinos. If neutrino and antineutrino are different, there is no escaping the emission of two antineutrinos along with the two electrons. Decays of this kind would be so rare as to have associated half-lives of the order 10^{21} years, and they would be undetectable with present instrumentation. If the two kinds of neutrino are the same, then one could be 'virtually' emitted as an antineutrino, and immediately be re-absorbed in the guise of a neutrino. Then only the two electrons would emerge from the nucleus. Associated half-lives would be of the order 10^{13} years, and would be barely observable. The experiments have been tried four or five times, and the two latest—one at the University of Rochester and the other at Western Reserve University—have found no double beta decay within half-lives of 10^{17}-10^{18} years for four elements, so the implication is rather strong that the neutrino and the antineutrino differ. . . .

"The distinction between neutrino and antineutrino is evidently a subtle one, and it brings us finally to the question which the writer has so far avoided with success, if not with downright skill. What *is* a 'fundamental' particle, anyway? If asked, some physicists might attempt a formal definition; others, like the writer, would become cagey; but all would have certain concepts in mind. A fundamental particle is an entity capable of independent existence; that is, it is not a mere assemblage of other particles. It must also have a unique set of intrinsic properties, of which those that we recognize and measure (when we can) are: the rest mass (which apparently can have any value from zero upward), the charge (so far always −1, 0, or +1 in terms of the electronic charge), the spin or intrinsic angular momentum (so far restricted in observation to the values 0, ½, and 1 in units of $h/2\pi$), the magnetic moment, the relative direction of spin and magnetic moment vectors (parallel or antiparallel), the lifetime (from zero to infinity) and the parity (even or odd). We see, however, that such a list gives no room for a difference in properties between neutrino and antineutrino. A difference would be permitted if the neutrino were granted a small but finite magnetic moment, but it may be that the list is simply incomplete.

"We pass now to the *proton*, long familiar as the nucleus of the hydrogen atom, and a determining constituent of all nuclei. One puzzle, still unsolved, is the accounting for the size of the magnetic moment, which is 2.79 times larger than it should be according to conventional ideas. It is customary to attribute the magnetic moment to a 'meson cloud' attached to the proton, but this remains largely in the status of a suggestion; no quantitative theoretical accounting has yet been given.

*"We have adopted the convention that negative beta decay is accompanied by emission of antineutrinos, and positive beta decay by neutrinos. When the distinction need not be drawn, we speak simply of neutrinos."

The distribution of positive charge inside the proton has recently been measured at Stanford University, using a beam of 550 Mev electrons, the wave length of which is comparable with nuclear dimensions. From the angular distribution of the electrons scattered from a hydrogen target, it is possible to infer that the proton is not a point charge of positive electricity, but rather an approximately Gaussian distribution with a root mean square radius of 0.75×10^{-13} cm. The magnetic field of the proton has a similar shape.

"The discovery last year of the *antiproton* at Berkeley confirmed the long-standing belief that the proton obeys the Dirac theory. The rest mass of the proton is 938 Mev; according to the hole theory twice this energy would be required for the creation of the proton-antiproton pair, but in actuality the bombarding energy required is higher (5.6 Bev) because a major part remains in the kinetic energy of center of mass motion of the incident and the target particles. The big accelerator* was designed several years ago for an energy of 6.3 Bev, and it is now clear that this foresight has paid off magnificently. The experiment itself was sophisticated and complex; it required the detection and identification of a few particles in the presence of many thousands of others, with the initial handicap that the experimenters did not know exactly what kind of annihilation event to look for. . . .

"The *antineutron* fell from the same basket as the antiproton. The fairly frequent process of charge exchange, known to take place in close encounters at high energy, enabled antiprotons from the bevatron to lose charge to ordinary protons in matter, so that they turned into antineutrons. Thus the weak original antiproton beam had a neutral component added to it, and the antineutrons could be recognized by their lack of deflection in magnetic fields and by the characteristic energy released upon annihilation. (Annihilation of antineutrons and antiprotons gives a nuclear explosion, accompanied by emission of protons, neutrons, nuclear fragments, and sundry of the heavier mesons.) Thus one of the developments of very recent years has been the generalization of experimental confirmation of the pair theory for particles of spin ½ from sole reliance upon electron-positron pairs to reliance also upon proton-antiproton pairs, neutron-antineutron pairs, and probably neutrino-antineutrino pairs. It is now legitimate to speculate about atoms with negative nuclei and positive electrons; the 'contraterrene matter' of science fiction has come into its own, and astrophysicists are on the lookout for parts of the cosmos where such matter may indeed exist.

*See *Sky and Telescope*, December, 1956, page 64, and March, 1956, page 204.

"So far we have mentioned in this discussion particles that are stable in the free state. The *neutron* is one that is not. In a vacuum, it decays to proton, electron, and antineutrino with a half-life of 12 minutes and an energy release of 0.78 Mev. In combination with protons in stable nuclei, this decay is inhibited; nobody knows exactly how. Although electrically neutral, it nevertheless has a magnetic moment—a fact that also lacks detailed understanding. Neutron and antineutron presumably differ in the relative orientation of the magnetic moment with the axis of spin.

"The total number of neutrons and protons (jointly, *'nucleons'*) in the universe appears to be fixed. It has been a principle of all laboratory nuclear reactions that the number of nucleons is conserved. The principle appears also to make cosmic sense, because if there were any means by which nucleons could turn into electrons, photons, and neutrinos, a corresponding inverse materialization process would be hard to imagine, and the universe would have degraded into the lighter particles considerably before 1957 A.D.

"The table of the elementary particles for 1956 that accompanies this article may not be quite up-to-date in the finer details, but it shows the general picture well enough for present purposes. The 'classical' particles are grouped at mass zero, mass one (electron) and, after a wide gap, there comes the close neutron-proton doublet at mass 1837. In between, and at larger masses with no apparent regularity, come the *mesons*—all of which are unstable. The prediction (1935) by Yukawa of a particle of mass about 200 times that of the electron as an agent in the action of nuclear forces was a triumph comparable in genius with Dirac's prediction of the positive electron. The Yukawa particle was indeed finally found; it is the *π-meson*, or *pion*. The intervening episode of the discovery of *μ-mesons* (*muons*) in cosmic radiation, the flurry of excitement following the observations, the reservations held by many, and the final demonstration that the muons could *not* be the Yukawa particles because they interact only weakly with nuclei—these are matters within the experience of many. The situation was relieved when the cosmic ray group at Bristol found the pions, and demonstrated by the skillful use of new photographic emulsion techniques that the pions do indeed interact strongly with nucleons, and that they fulfill many of the requirements of the Yukawa particles.

"The pions are important, and much has been written about them. They are generated copiously in high-energy nuclear reactions such as are produced in the modern large accelerators, several sometimes coming from a single nuclear collision. The neutral pion decays very rapidly (10^{-15} sec) into two gamma rays. The negative pion in free space would decay with a half-life 2.5×10^{-8} sec into a negative muon plus (presumably) a neutrino, but in experimental observation it interacts with matter and usually does not follow this course. Instead, its negative charge draws it toward a nucleus, with which it merges, its rest mass contributing enough energy to explode the nucleus. In nuclear emulsions the picture is typical; the thin pion track ends in a star of thick, heavy-particle tracks produced by nuclear fragments, radiating from a point. Positive pions suffer Coulomb repulsion from nuclei, and do not penetrate unless they are traveling at high speed. Normally they slow down in matter and decay into positive muons plus neutrinos. Pions can be produced by the interaction of high-energy photons with nuclear matter.

"The muons have been called the useless particles of physics. Nearly all that we see are merely the decay product of pions, where they seem to constitute an unnecessary step in the total decay of the pions into electrons and neutrinos. They are common in the penetrating component of cosmic rays. The spin is ½, so the negative and positive varieties presumably form an antiparticle pair; in fact, an experiment at Stanford recently gave evidence of muon pair creation by high-energy photons. Neutral muons are not known; they might be hard to find. Muons decay spontaneously into electrons, positive or negative according to their charge, with a half-life of about 2 microseconds, but the decay electrons do not possess a unique energy. This means that there must be a three-body breakup, and the two undetected particles are commonly supposed to be neutrinos.

"At mass 966 in our table, there occurs a complex of particles called the *K-mesons*. They first began to be found in the cosmic rays, revealing themselves as very rare events in emulsions and in cloud chamber photographs. The modern accelerators have increased the intensity of the available K-particles manyfold, although they are still rare compared with pions and muons. Sufficiently detailed observations have been made to indicate that the masses are all 966 times the mass of the electron, within the rather narrow experimental error of about 3 electron masses. The question then arises, are there really six different particles in this group? . . . .

"Such is a sketch, once over lightly, of the phenomenology of the physics of elementary particles. . . .

" . . . The experience of physics leads us to expect that as experimental knowledge improves, regularities will emerge, theories will develop, and the present scattered picture will develop cohesion. Meanwhile, the situation is as stimulating as any that have challenged the human intellect, and the physicists of the mid-twentieth century are having an exciting time."

ASTRONOMICAL SCRAPBOOK

Roger Boscovich and the Moon's Atmosphere

EVER SINCE the first telescopic studies of the moon some 350 years ago, astronomers have searched for phenomena that would indicate the presence of an atmosphere surrounding our satellite. Successively more and more sensitive tests have failed, but there has always been enough dissenting opinion to provide stimulating controversy.

The history of the search for a lunar atmosphere seems very incompletely covered in all the recent books on the moon. In particular, the important role played by Roger Boscovich (1711-1787) has gone largely unnoticed, and his book on the subject is seldom mentioned, if at all.

This Jesuit astronomer was a Slovene (from present-day Yugoslavia), and not an Italian as usually stated. Born at Dubrovnik (Ragusa), he went to Rome in 1740 to become professor of mathematics at the Collegio Romano. His scientific work was extremely varied and influential, including the invention of astronomical instruments, studies of eclipses and transits of Venus, methods of computing comet orbits, hydraulic engineering, important contributions to pure mathematics, and a penetrating study of the nature of gravitational attraction. Besides this, he at one time served as the ambassador of his native Ragusa, then an independent republic, to the court of France.

His interest in the lunar atmosphere problem seems to have been stimulated by the annular eclipse of the sun on July 25, 1748, which was widely observed in Europe. At Berlin, the famous Swiss mathematician Leonhard Euler watched the course of the eclipse by projecting the solar image on a white screen fastened behind the eyepiece of his telescope. On this screen he had drawn a circle just large enough to contain the sun's disk. But when the eclipsed sun had become a crescent, its cusps apparently extended beyond the circle.

This effect, Euler noted, would result from the refraction of sunlight by air on the moon. He critically analyzed this observation in a memoir read before the Berlin Academy of Sciences in 1748, concluding that the lunar atmosphere was dense enough to produce a horizontal refraction of 20 seconds of arc. (The terrestrial horizontal refraction is 34 minutes; we see a star on the horizon when it is actually this angular distance below it.)

Euler's paper led Boscovich to a comprehensive study, published at Rome in 1753 as a 76-page book, *De Lunae Atmosphera*. This is a systematic exploration of the phenomena that should be observable if the moon possessed an appreciable atmosphere. As far as the optical theory of his day permitted, Boscovich made specific, quantitative predictions, which he compared with the observations available. The whole discussion is crisp and businesslike, and so modern is Boscovich's viewpoint that his book is worth reading even today.

If the moon had a gaseous envelope, the Jesuit astronomer pointed out, a star or planet undergoing occultation would suffer very distinctive changes in appearance. As a star neared the moon's limb, it would be displaced outward more and more by refraction, the shift at the moment of disappearance being twice the horizontal refraction—40 seconds, if Euler had been right. This effect could be tested by repeatedly measuring the angular distance of the star from the moon's limb. Moreover, the star's light would become increasingly dimmed and reddened. A planetary disk about to be covered by the moon would appear flattened, just as does the setting sun.

In addition, because blue light is refracted more strongly than red, a star very close to the moon's edge would be spread out into a spectrum, with its red end toward the moon. If the horizontal refraction by a lunar atmosphere were as great as 20 seconds, the spectrum ought to be nearly two seconds long, according to Boscovich. This he considered too small to be recognized in the telescopes of his time. In the case of a planet, however, the effect would be easier to see, the planet's edge nearer the moon having a red border.

Roger Boscovich, S. J., was accomplished in so many fields that he is difficult to classify. He was mathematician, astronomer, philosopher, engineer, poet, and diplomat. His friends included King Louis XVI of France, and he was a member of the Paris Academy of Sciences and of the Royal Society in London. This portrait is reproduced from "L'Astronomie" for November, 1937.

Something of this sort had indeed been recorded by Delisle and by Louville in France, when Venus was occulted in 1715. But they used nonachromatic refractors of inferior quality, and Boscovich dismissed their findings, particularly as such colored fringes had been looked for but not seen at other occultations of planets.

At solar eclipses a dense lunar atmosphere could betray its presence in several ways. The cusps of the solar crescent would be prolonged, and the irregularities of the moon's edge smoothed out. And could the corona seen at total eclipses be interpreted as an extensive sunlit lunar atmosphere?

"No," answered Boscovich. On pages 57 to 60 of his book he summarized the available reports on the corona, beginning with Kepler's of 1605. The corona must be an appendage of the sun rather than the moon, he decided. For one thing, at the total eclipse of 1715 it had unequal extent in different directions, unlike an atmospheric shell. Also, in 1724 Maraldi had noted that the corona was concentric with the sun rather than the moon.

Some of the other tests for air on the moon, marshaled by the Jesuit astronomer, were: the phases of the moon should differ slightly from prediction; diffuse and gray mountain shadows instead of sharp and black; soft and blurred surface detail near the limb. Boscovich attributed to Huygens the idea that lack of lunar clouds denies an atmosphere, but regarded this as an insensitive test.

Partly with the aid of his own observations, Boscovich concluded that none of these signs of a lunar atmosphere had been observed beyond question. Euler was clearly wrong; the moon's air, if any, had to be considerably less dense than he had announced.

Though Boscovich's book is little known now, it must have been widely read in its day. In the year after it was published a second edition appeared at Leipzig, and a third at Vienna in 1776. Some years later, when Schröter and Gruithuisen wrote in support of a lunar atmosphere, their views met little acceptance. On the other hand, the skepticism in Beer and Mädler's book of 1837 was generally adopted by astronomers. These reactions may, in part, have been due to the continuing influence of Boscovich's treatise.

JOSEPH ASHBROOK

Correction: In the chart of the Mizar-Alcor field in this department for April, page 265, the label "SL" should be transferred to the star ¾ inch below and ⅝ inch to the right of Alcor. The error affects only the diagram and not the story.

About a Russian Astronomer

OTTO STRUVE, *Leuschner Observatory, University of California*

B. P. Gerasimovich, as he appeared in 1936, while director of Poulkovo Observatory. Photo by D. H. Menzel.

I HAVE just finished reading an absorbing new book on the history of Russian astronomy from its beginning, about 1,000 years ago, until the November, 1917, revolution. A few comments may be in order for those who derive inspiration and guidance from studying the great minds of former generations.

The author of *Outlines of the History of Astronomy in Russia* is B. A. Vorontsov-Velyaminov, a well-known astronomer on the staff of the Sternberg Astrophysical Institute of Moscow University. He has made many significant and sometimes penetrating contributions to astrophysics, but he is perhaps best known as the author of scientific monographs, textbooks, and popular volumes. In 1949 I reviewed in the *Astrophysical Journal* the latest Russian edition of his monograph on gaseous nebulae and new stars. There I criticized severely, though I believe not unjustly, the large amount of political propaganda it contained, as well as the many unfair and irresponsible attacks on western astronomers.

Professor Vorontsov-Velyaminov has now written on what was a highly controversial topic a few years ago—the value of prerevolutionary scientific effort, mostly, of course, in czarist Russia. I am struck by his fairness and well-balanced judgment in emphasizing real contributions to astronomy by many different persons and institutions, and in reporting more briefly and kindly their failures and disappointments.

The fact that this book was printed and distributed at all makes me hope that what I say here will help to correct probably the worst wrong in the history of astronomy since the days of Galileo. I hope further that my words can help improve understanding among astronomers on both sides of the ideological curtain. If I am mistaken, my excuse is the compelling sense of responsibility an older man feels when he is one of the few persons whose memories have preserved facts and impressions that should be known to all. I propose to write about the late Boris P. Gerasimovich, who was born in 1889 at Poltava, in the Ukraine.

His name does not appear in Vorontsov-Velyaminov's book. In part this may be because the last half of his life and most of his research belong to the postrevolutionary era. But many of his contemporaries are mentioned, and there is even a generous reference to myself as the product of one of the Russian state universities. Furthermore, Gerasimovich's name never appears in any of the recent histories of the Poulkovo Observatory, although he was its director for years; nor does it appear in the history of the Kharkov Observatory, where he was the most distinguished staff member between about 1915 and 1930.

There is no explanation for these omissions, except on grounds of ideological suppression. Never in modern times has the death of an astronomer of comparable stature failed to be recorded in at least a short article on his life and work. No obituary of Gerasimovich has, to my

The historic Poulkovo Observatory housed a 15-inch refractor in the central turret of the main building. Behind the trees at the right is the dome of the 30-inch Clark refractor. The observatory was destroyed in World War II; photographs and an article about its reconstruction were published in the November, 1954, issue of this magazine.

knowledge, ever been printed, yet 30 years ago his name was internationally famous.

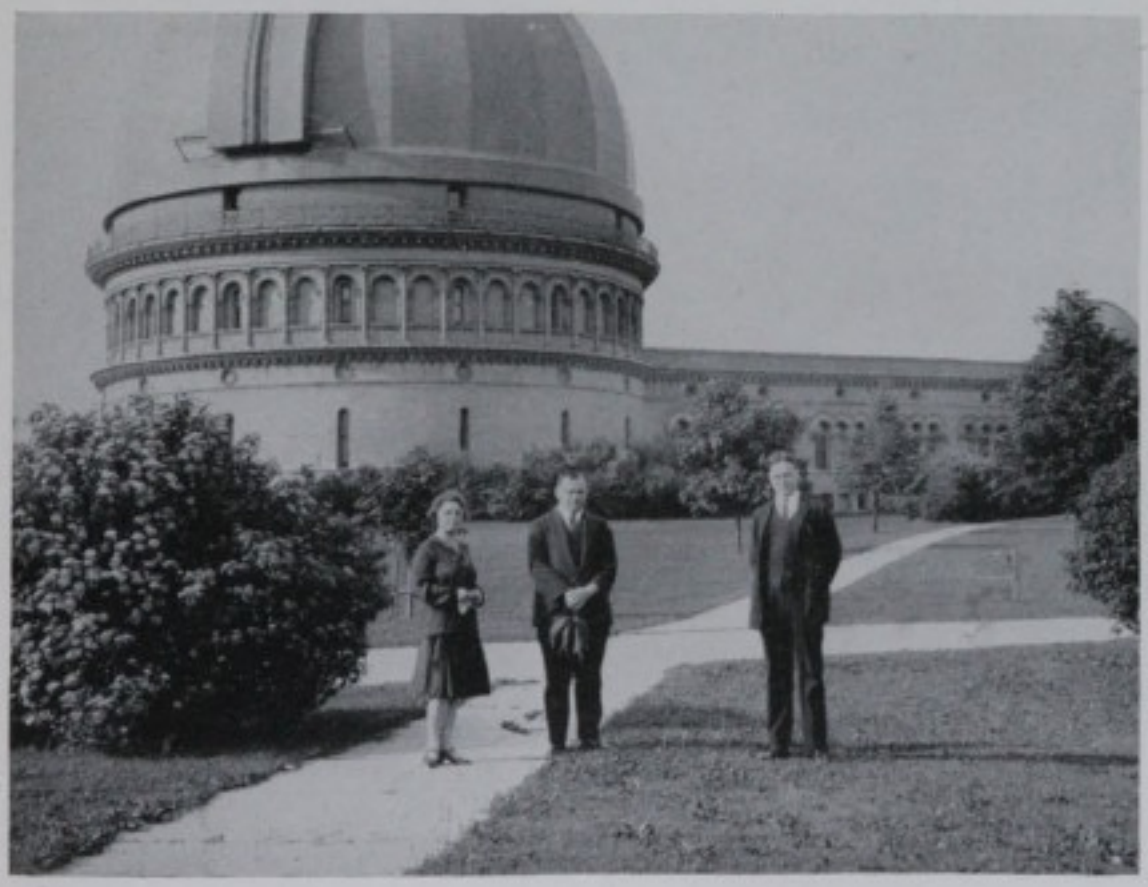
He disappeared just 20 years ago in the bloody purge of 1937, but, unlike a number of other scientists, he was not executed. He simply vanished. A few years later, when a western astronomer who had once been a Poulkovo staff member visited his old home in Russia, he inquired about the fate of Gerasimovich, but encountered only expressions of fear and ignorance. But we know now from a reliable source, a prominent Soviet astronomer, that Gerasimovich was sentenced to 10 years of forced labor and that he now is dead—that is all. There was no official announcement of the crime of which Gerasimovich had been accused. What is known to me from other sources I shall mention later.

In the past few years the cloak of secrecy has been lifted in the cases of many other victims of the political purges, and their reputations have been restored. Several astronomers who were also sentenced in 1937 were released at the expirations of their terms of imprisonment, and have been exonerated. Gerasimovich is presumably dead and his reputation remains stained. May we hope that his case, too, will be reconsidered?

Such an action by the Soviet authorities would inspire his friends; it would restore to a distinguished astronomer's accomplishments the fame they deserve.

I first met Gerasimovich in 1914, a year after he became a student of astronomy at Kharkov University. My father, his principal professor, often told me that Gerasimovich was the second best student he had had in 25 years of university teaching (the best was V. G. Fessenkov). After completion of the regular course, my father planned to send him abroad for additional training, but Gerasimovich was a socialist and the czarist police refused to issue him a passport for foreign travel. He therefore went to Poulkovo where he became a pupil of A. A. Belopolsky, undertaking an important study of the curious spectrum of the star Cor Caroli—the prototype of the spectrum variables. When I myself became a university student, Gerasimovich was a young instructor at Kharkov, and it was he who started me on my lifework, the study of stellar spectra. He was an inspiring teacher, firmly rooted in the massive foundation of the progressive cultural life of old Russia. His many scientific accomplishments have become part of this solid foundation.

I did not see Gerasimovich again until 1927 at Harvard Observatory. By that time he had established a reputation as an able astrophysicist, and had attended one or two international meetings. I remember him telling me of his visit to Copenhagen for a meeting of the Astronomische Gesellschaft, where he had felt humiliated by what he thought was disdain on the faces of some western astronomers because of his proletarian attire, especially his yellow shoes. At Copenhagen he first met Harlow Shapley, and at the latter's invitation he decided then and there to visit the United States. This period of his life, in 1927-29, while on leave of absence from the Soviet Union, was quite productive in scientific results. Numerous articles by him appeared in some Harvard Observatory publications, the *Astrophysical Journal*, the *Astronomische Nachrichten*, and elsewhere.



This snapshot was taken in 1928 on the lawn of Yerkes Observatory, with the dome of the 40-inch refractor in the background. It shows Mrs. Olga M. Gerasimovich at the left, Dr. Gerasimovich in the center, and Dr. Struve, then on the staff of Yerkes, at the right.

Gerasimovich worked on a wide variety of subjects and was usually concerned with the latest theories and hypotheses. For example, he was one of the first astronomers to give serious consideration to the astronomical aspects of cosmic rays, which he called "penetrating radiation." He wrote on the absolute magnitudes of the central stars in planetary nebulae, establishing that they are not nearly as faint, intrinsically, as had been assumed from A. van Maanen's trigonometric parallaxes.

He investigated the theory of ionization in stellar atmospheres and in interstellar gas, and he made many contributions to the study of variable star light curves.

Because most of the problems he attacked were novel at that time, many of his results have been surpassed by later workers, but his papers stimulated research and often were the starting points of subsequent investigations. His purely observational studies—of variable stars, stellar spectra with emission lines, and the like—have retained their value. Gerasimovich's bibliography contains about 150 titles, in the Russian, English, French, and German languages, and a few even in Ukrainian—the official language at the University of Kharkov after the revolution.

Gerasimovich introduced me, an observational astronomer, to the marvels of theoretical interpretation of observations, and we published jointly a now almost forgotten but basic paper on interstellar absorption lines. This was in 1928, when he was at Harvard. We spent many hours together, and I remember accompanying him and Mrs. Gerasimovich to a Boston showing of the famous Russian motion picture "Potemkin."

In 1928 Gerasimovich and Donald H. Menzel were jointly awarded the A. Cressy Morrison prize of the New York Academy of Sciences for their pioneer work on the source of stellar energy. This paper was later printed in the *Publications* of the Astronomical Society of the Pacific (*41*, pages 79 and 145, 1929) under the title *Subatomic Energy and Stellar Radiation*. It was one of the earliest efforts to apply statistical mechanics to the problem of the liberation of stellar energy. The authors clearly recognized the importance of a highly energetic field to trigger the reactions.

Gerasimovich left the United States in 1929, and soon afterward was appointed the director of Poulkovo Observatory. I did not see him again until 1932, when he revisited America to attend the general assembly of the International Astronomical Union at Harvard. He was full of enthusiasm for the impressive advancement of science under the Soviet government; he urged me to go to Poulkovo and to

collaborate with him in several astrophysical investigations. He also tried to enlist my help in editing and preparing for publication the extensive personal correspondence of Wilhelm and Otto Struve with the Herschels, Leverrier, Bessel, Airy, and most of the other outstanding astronomers of the 19th century. As far as I know, this valuable historical material remained at Poulkovo after Gerasimovich's disappearance, but it seems to have been destroyed during the siege of Leningrad in World War II.

Gerasimovich asked me to buy for him scientific books and periodicals, and during the next few years he occasionally sent to me through the mails American $5 and $10 bills, which he probably bought on the black market in Russia. After our large paper money was replaced by bills of smaller size, the old-style money that came from Gerasimovich caused me some embarrassment. My bank wanted to know why I had hoarded the old bills and was depositing them in my account one at a time! In 1947 I returned the balance through a friend to the family of Gerasimovich.

After becoming director of the Yerkes and McDonald Observatories in 1932, I gave a lecture at the University of Texas on freedom of thought in astronomy. In it I made several unfavorable comments on the suppression of intellectual freedom in the Soviet Union. The lecture was printed in *Scientific Monthly*, and after a considerable lapse of time it became known to astronomers in Russia. A caustic reply by Ogrodnikov and Subbotin was printed in the astronomical periodical *Mirovedenie* in 1935. When Gerasimovich learned of my article and the Russian reply, he sent me a highly critical letter asking me not to write him again and not to send any more reprints and books. But he continued for a year or two to mail me brief notes, often without signature.

Once in 1936 he sent me a newspaper clipping of an article in which he was taken to task for having published most of his scientific papers in Germany and the United States. The tone of the article was ominous but apparently there were no immediate consequences. Gerasimovich was still the director of Poulkovo in 1936 at the time of the total solar eclipse when Dr. Menzel and other American astronomers were his guests.

The Harvard party arrived at Leningrad in April, 1936, and its members were met by Gerasimovich at the train. They had the impression that he already suspected he was being spied upon. He admitted privately that some years earlier he had spoken out sharply against the government but this had been a mistake, and the government was now giving science the support to which he felt it was entitled, with the observatory better off than at any time in history. He apparently suspected that one or two members of the Poulkovo staff were conspiring against

This is the equipment set up by the Harvard-M.I.T. expedition to Ak-Bulak, in Siberia near the Caspian Sea, to observe the solar eclipse of June 19, 1936. The site was chosen with the advice of Dr. Gerasimovich, who led a Russian expedition to the same part of the path of totality.

him, but he had no serious premonitions. After the eclipse Dr. Menzel learned from a New York *Times* correspondent that his "Russian friend" was in difficulty because of alleged inefficiency in office.

At the Siberian eclipse camp in Ak-Bulak, Gerasimovich had mentioned to Menzel his wish to revisit Harvard and resume some of the investigations he had started seven years earlier. Hence, in October, 1936, Shapley and Menzel sent the Russian astronomer an invitation to give a series of lectures at Harvard. The last message they received from him, about February 1, 1937, read: "Sorry regret cannot come."

At about the same time, I received a short unsigned note in Gerasimovich's handwriting, stating he was in deep trouble and would have to discontinue all relations with me. The breath of fear and utter despondency pervaded every word of his letter. A few days later he must have stood before his judges, never to be seen again by his family and associates. Until about a year ago, his name was not again mentioned in Russian scientific literature, and it was actually blocked out by a superposition of printer's ink in publications that had been printed but not distributed before his disappearance.

The most explicit account of the accusations against Gerasimovich appeared in an article dated July 29, 1937, in *Mirovedenie* (December, 1937, pages 373-377), by its editor, V. T. Ter-Oganezov. The article stated that the secret police had "liquidated" some "enemies of the people" in Soviet astronomical organizations. Among these, the account goes on, was an astronomer who, 10 years earlier at the University of Kharkov, had expressed views that opposed the "Marxist-Leninist methodology in the natural sciences," showing he was not a true adherent of the Soviet system.

We need not review the article in full here—it is available in the Library of Congress and I have a copy in my possession. My purpose is not to discuss its tone of hate, but to suggest that some of the accusations in it are certainly not true. Others may only mean that Gerasimovich was unable to carry out his heavy administrative duties as director of Poulkovo Observatory. He had, in fact, offered to resign long before he was arrested, but the Academy of Sciences asked him to continue in office.

It would seem that there were deep differences of opinion among Russian astronomers in 1936. Even were Gerasimovich wrong on occasion, surely his errors did not justify the fate that befell him.

NEW 84-FOOT RADIO TELESCOPE FOR NRL

On the banks of the Potomac River near Riverside, Maryland, some 45 miles south of Washington, D. C., the Naval Research Laboratory is erecting an 84-foot equatorially mounted radio telescope. The surface precision of its paraboloidal aluminum reflecting surface will permit radio observations to wave lengths as short as 10 centimeters.

For years NRL astronomers have operated a 50-foot radio telescope mounted on the roof of a building at the laboratory in a suburb of Washington. The new, more powerful instrument will provide for an expansion of their program of astronomical research, which has included work on the planets, the sun and moon, and the Milky Way.

Amateur Astronomers

An Observatory with an Artistic Touch

TO RECALL an era of the past, when labor costs were of little consideration and telescope instruments were decorated by their owners, Winthrop H. Hall has erected an observatory of unique appearance to house an artistically designed 6-inch f/17 refractor.

The red-brick octagonal observatory pictured here matches the colonial-type architecture of Dr. Hall's home at Westfield, New Jersey. Soapstone tablets on the faces of the building are hand-etched with such information as the observatory's name, its longitude, latitude, and height above sea level.

The writer assisted in the construction of the telescope according to Dr. Hall's ideas. As the closeup of the mounting shows, function was not subordinated to appearance. The heavy metal used, bronze and brass, necessitated substantial parts, and the total weight of the instrument is 420 pounds. The objective lens was made by Earl C. Witherspoon, Sumter, South Carolina.

For the axles, hot-rolled steel was used to avoid any strains after machining. Ample internal flanges join the "T" and the saddle piece, to insure perpendicularity. The declination shaft runs in sealed ball bearings, and the polar axle is supported at its north end by an enclosed ball thrust bearing and a heavy needle bearing with a 1¾-inch inner race diameter. Size for size, a needle bearing permits a thicker shaft, and it could even be used without an inner race. The south end of the polar axis is supported by a ball bearing of more than 1½ inches inner diameter.

The setting circles are 12-inch bronze castings, engraved by Stanley Brower with 720 lines each, which are read by five gold pointers at the ends of the three indicator bars. Dr. Hall has carved the constellation figures of Cancer, Taurus, Sagittarius, and Leo in the interior field of the circles. Each circle is equipped internally with an especially manufactured brass ring gear, providing continuous slow-motion control by means of the handwheel.

For the electric clock drive only stock Boston gears were used; the 1/150-horsepower Bodine motor drives the telescope at the sidereal rate, with an error of only 1/6 second in 24 hours. The electric wires come up through the telescope pier.

Not shown in these pictures are a finder and a small solar telescope, mounted 90 degrees apart at the eyepiece end of the main instrument. All the parts and the telescope tubes were sprayed with lacquer after the bronze and brass had been finally polished.

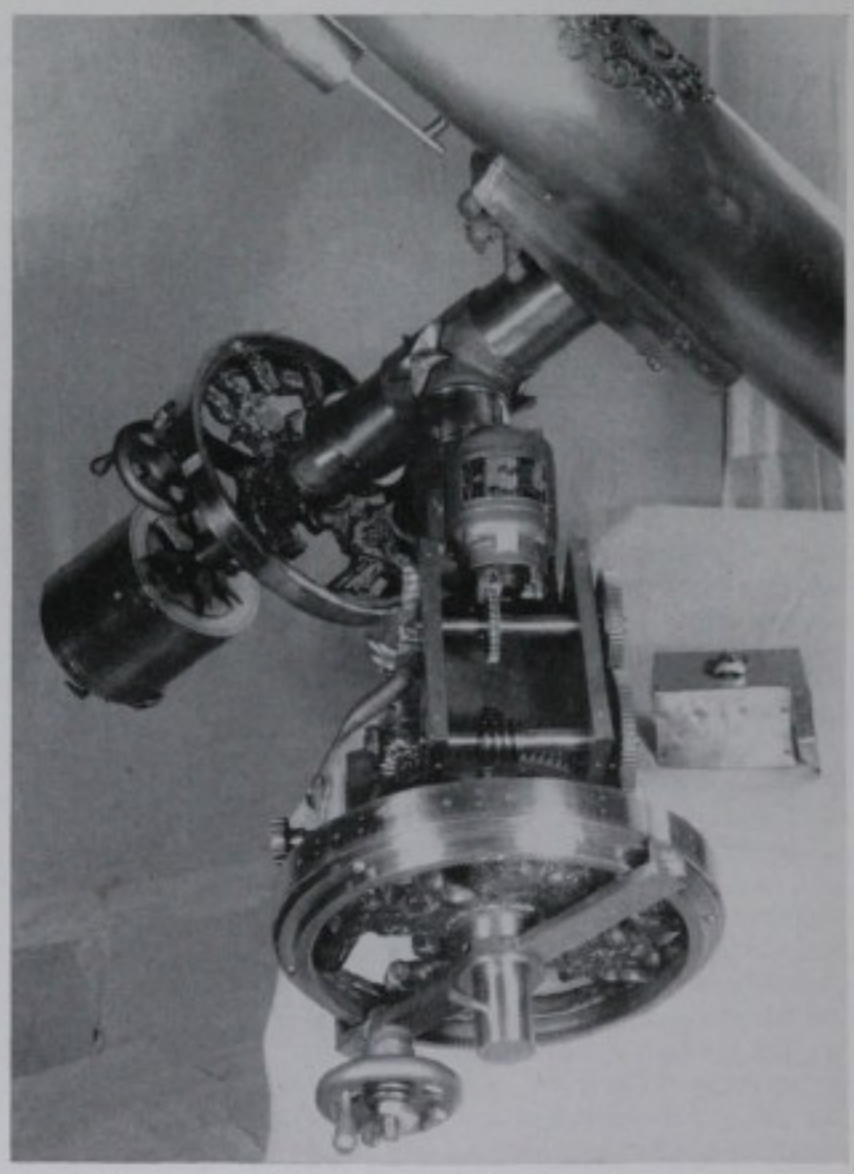
Dr. Hall has embellished the big refractor with figures of fauna, and has engraved such astronomical information as the equation of time and the coordinates of nebulae on the counterpoise of the instrument.

HANS PFLEUMER
596 First Ave.
New Brunswick, N. J.

AAVSO MONTREAL MEETING

The American Association of Variable Star Observers will hold its 46th spring meeting in Montreal, Canada, May 31-June 2. Sir George Williams College and the Montreal Centre of the Royal Astronomical Society of Canada will be hosts.

On the evening of the first day, Dr. J. S. Marshall, of McGill University, will talk on storm studies by radar, to be fol-



The observatory of Winthrop H. Hall blends with the architecture of his estate in New Jersey. It houses a 6-inch refractor of 102 inches focal length. The telescope's mounting is shown at the right, assembled in the workshop where it was built. The cover of the gear train has been removed. Note the decorations on the telescope tube and inside the setting circles. Photographs by Hans Pfleumer.

lowed by a tour of Sir George Williams College. The association dinner will take place on June 1st at the Laurentien Hotel, the meeting headquarters.

Visits to the Montreal Centre's observatory on the McGill University campus and to the Dominion Weather Bureau are also scheduled. More information may be secured from the AAVSO, 4 Brattle St., Cambridge 38, Mass., or from Charles Good, 4169 W. Hill Ave., Montreal, Canada.

RACINE, WISCONSIN

The Racine Astronomical Society held its first meeting last September 7th at the time of the close approach of Mars. The club now has some 50 members.

Meetings are held each third Monday of the month at the University of Wisconsin Extension building in downtown Racine. Field trips to Washburn Observatory and star parties are also scheduled by the group.

The officers are: John F. Francis, president; Ronald Jones, vice-president; Orin H. Kindt, treasurer; and Mrs. Paula B. Carey, secretary. Further information may be had from Mrs. Carey, 1806½ Clayton Ave., Racine, Wisc.

TAMPA, FLORIDA

The Tampa Amateur Astronomical Society has about 25 members. We meet on the first Tuesday of each month, at Tampa University in the even-numbered months, and at the private observatory of M. M. Maner, 4908 River Blvd., in the odd-numbered months. Mr. Maner has a 10-inch refractor.

Besides 10 individually owned telescopes, there are two 6-inch reflectors belonging to the society that were made as a group effort. These two telescopes are rotated monthly among the members who do not own instruments. Two members are now making a 6-inch Newtonian and a 12½-inch Porter-Springfield reflector.

In addition to regular observing parties, we have sponsored public star parties in city parks. We're presently setting up a satellite-tracking station.

E. Z. RANDALL
407 West Chelsea St.
Tampa, Fla.

GREAT LAKES CONVENTION

The second annual meeting of the Great Lakes Region of the Astronomical League will be held on July 5-6 in Columbus, Ohio, with the Columbus Astronomical Society as host. Convention headquarters will be at the Fort Hayes Hotel.

Visits will be made to the Ohio State University radio telescope and the 69-inch telescope at Perkins Observatory, the fifth largest reflector in the United States.

George Nielson, McMillin Observatory, Ohio State University, Columbus 10, Ohio, may be contacted for accommodations. Program time can be secured from Jack Charlton, 642 Joyful St., Columbus 4, Ohio.

LEAGUE CONVENTION NOTES

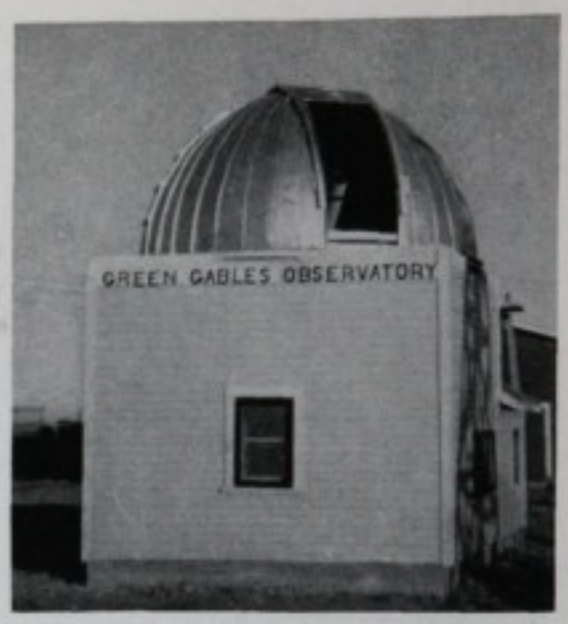
Dr. Richard N. Thomas, of the National Bureau of Standards, Boulder, Colorado, will be the principal speaker at the Astronomical League convention in Kansas City, Missouri, August 31-September 2. He will talk on current solar astrophysical research.

Other speakers will include: Dr. William C. Doyle, head of the mathematics department, Rockhurst College, who will give some popular aspects of astronomical mathematics; Dr. Joseph Shipman, director of the Linda Hall Library in Kansas City, who will discuss and show rare astronomical books; and Frank Vaughn, of the Association of Lunar and Planetary Observers, whose topic will be "From Schiaparelli to the Present." Dr. J. Allen Hynek and Dr. Armand Spitz, of the Smithsonian Astrophysical Observatory, will speak on the satellite-tracking program, including MOONWATCH.

Convention headquarters will be the University of Kansas City. Rooms in the university's new air-conditioned dormitory will provide quarters for 250 persons, at $2.50 a night per person.

Ample space will be provided for displaying exhibits at the Student Union building, according to J. E. Lynn, chairman of the display committee. The exhibits should be sent between August 20-29 to Astronomy Exhibits, University of Kansas City, 5100 Rockhill Rd., Kansas City, Mo.

Mr. and Mrs. Koken built this 6-inch refractor for Green Gables Observatory.



This amateur-built observatory in Kansas contains the 6-inch refractor shown at the bottom of this page.

GREEN GABLES OBSERVATORY

OUR observatory building was originally used for other purposes on the Green Gables grain and poultry farm. We took the roof off and raised the walls to nine feet high, to support the 12-foot dome. All parts of the dome were assembled on the ground and then placed on the building with a large crane.

The dome shutter is the up-and-over type, but we believe a shutter that slides sideways would be better. Electrical power turns the dome, by means of a sprocket that engages a chain around the inside of the base of the dome.

Within the observatory, on a heavy pier of cement, is our homemade 6-inch refractor, with a conventional German-type equatorial mounting. The curved observing staircase is about seven feet high to the top deck; it rolls on eight heavy casters to any required observing position. Handwheels facilitate rapid pointing of the instrument, and there are slow motions controlled by flexible cable attachments.

During the past three years, we have also made 3¼-inch and 4¼-inch refractors, besides several smaller instruments. Many people have attended our star parties, for interest in astronomy is growing in this part of Kansas.

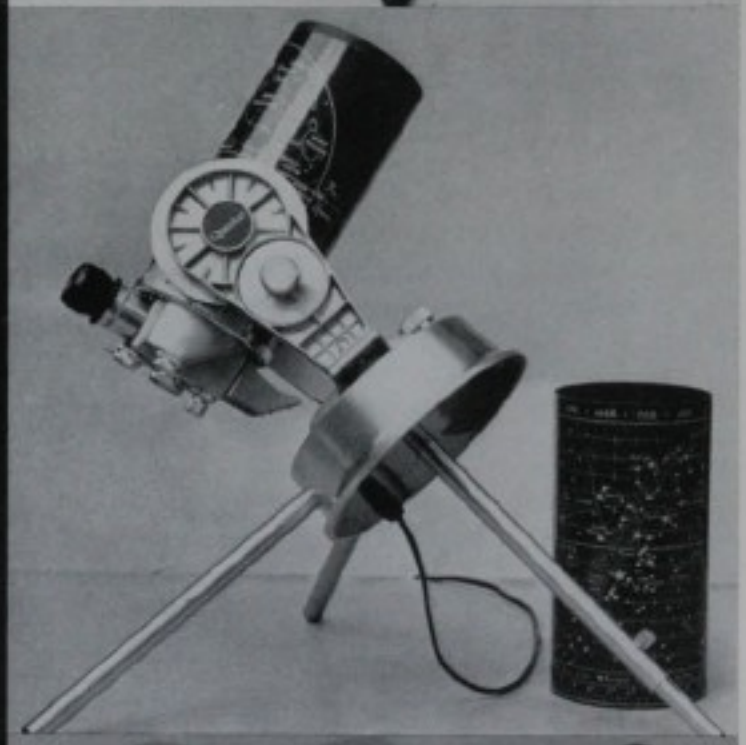
H. S. and ADDA M. KOKEN
Bird City, Kans.

EAGLE PASS, TEXAS

The Eagle Pass Junior Astronomical Club was organized last December with J. Russell Smith as counselor for the group. David Towns, 398 Pecos St., Eagle Pass, Tex., is club president, and may be contacted for further information.

THIS MONTH'S MEETINGS

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. June 1, Dr. Armand Spitz, Smithsonian Astrophysical Observatory, "Satellite Sidelights."

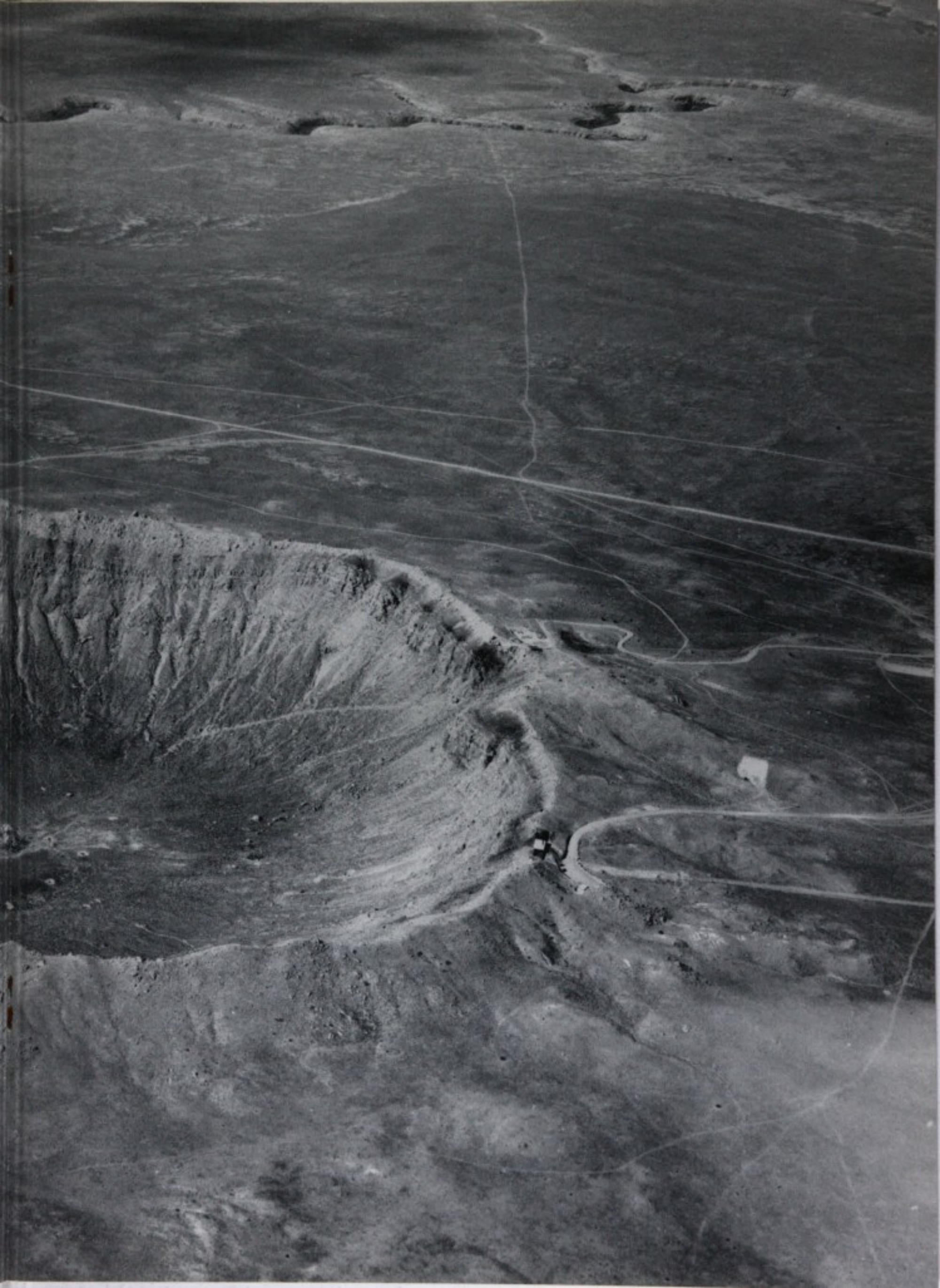


Questar

This picture of the waxing April moon shows the central portion of the lunar disk. It is another in the series taken by Mr. and Mrs. Ralph Davis with their 3½-inch Questar. The photograph is just the length and width of Questar's barrel. Beautiful photographs like these, without a trace of graininess, let Questar speak for itself. They tell the story of performance in the best possible way, by recording it for all to see.

The De Luxe Questar at $995 and Field Model at $495 are identical but for their mountings. Literature will be sent upon request. Time payments are available.

QUESTAR CORPORATION, New Hope, Pennsylvania



BOOKS AND THE SKY

ANTARCTICA IN THE INTERNATIONAL GEOPHYSICAL YEAR

American Geophysical Union, 1515 Massachusetts Ave. N.W., Washington 5, D. C., 1956. 133 pages. $6.00.

ANTARCTICA is larger than the continental United States plus Mexico. It is almost entirely inside the Antarctic Circle, and owing to the rigorous climatic conditions has no permanent habitation. The principal animal life is the "insatiably curious" penguin, and the chief vegetation in the rare regions not covered with snow or ice is lichen. About 90 per cent of the world's ice is in Antarctica, and it is estimated that if all this ice should melt the mean sea level of the earth would rise 198 feet (glaciologists reassure us that this is not likely to happen). Thus, to live in Antarctica is to return to the ice age.

During the International Geophysical Year, 11 nations (Argentina, Australia, Chile, France, Great Britain, Japan, New Zealand, Norway, South Africa, Union of Soviet Socialist Republics, and the United States) will operate 37 stations in Antarctica, making measurements in 10 different fields: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, meteorology, oceanography, rocketry, and seismology.

The scientific roster at the seven U. S. stations will number about 100, 38 being in meteorology. This concentration is due to the fact that the IGY Antarctic Weather Central, responsible for weather analyses and forecasts, will be operated by American personnel.

On April 26-27, 1956, the American Geophysical Union sponsored an antarctic symposium to evaluate the major scientific problems that should be studied during the IGY, as well as to furnish a general background of existing knowledge. This compilation of the original lectures in book form serves the very important purpose of making available a handbook for workers in Antarctica, which may also be read by those (including the reviewer) who prefer heroic armchair explorations.

Of the 16 papers, two deserve mention here. In "The Aurora Australis and Related Phenomena," E. H. Vestine gives a valuable compilation of the systematic observations that have been made of the southern lights. He also surveys the interpretation of these data. As in the Northern Hemisphere, the *center* of the zone of maximum auroral activity in the Southern Hemisphere is displaced from the geographic pole by about 11 degrees. In the north this is near Thule, Greenland, while in the south it is at a longitude of about 90° east, halfway between the geographic south pole and the Antarctica coast. A large portion of this continent lies *inside* the zone of maximum auroral activity, but a part of western Antarctica (off the tip of South America) is outside the zone. Therefore, the observing stations will be able to obtain a large amount of synoptic data on the aurora australis during the IGY.

The paper by J. A. Simpson, on "Cosmic Ray Experiments Derived from Recent U. S. Antarctic Expeditions," illustrates the important by-product scientific results obtained from a program primarily devoted to another project. Taking advantage of two sailings to the antarctic (USS *Atka*, 1954-55; USS *Arneb*, 1955-56), Simpson and his colleagues have established the existence of a geomagnetic longitude effect for cosmic ray intensities. The interpretation offered is that the earth's outer magnetic field does not coincide with that predicted by surface measurements. This brings up the interesting astrophysical problem of a rotating and magnetized body (the earth) immersed in a highly conducting medium (the interplanetary electron density near the earth is thought to be 600 per cubic centimeter, based on zodiacal light and "whistler" interpretations).

This reviewer read the compilation with the large Antarctica map included in the book before him. Although the individual papers are basically technical in nature, their total impact is an overwhelming feeling of amazement at the grandeur and daring of the entire enterprise. In the present era of human history (prespace travel), the IGY antarctic program offers the greatest challenge to those scientific adventurers who feel impelled to procure their data the hard way.

FRANKLIN E. ROACH
Central Radio Propagation Laboratory
National Bureau of Standards

THE SUN

Giorgio Abetti. The Macmillan Company, New York, 1957. 325 pages. $12.00.

AMONG the books written for general reading about the sun, Abetti's is perhaps the most comprehensive. The style in most places is smooth and easy to follow, and the level of presentation is such that it is interesting both to the layman and the specialist in the field. Almost every general subject of solar astronomy is discussed to some extent, and certain topics, such as the measurements of rotation rates of various latitudes and altitudes in the solar atmosphere, are presented with a pleasing degree of thoroughness. Some recent research, for instance solar radio noise observations, are treated in a more sketchy fashion.

The present English version, translated from the Italian by J. B. Sidgwick, is based on the third edition of the book, the first having been published in 1934, the second in 1951. The various revisions have

For every astronomical interest . . .

THE
HISTORY
OF THE
TELESCOPE
by Henry C. King

The book is excellent, and the illustrations numerous and luxurious.[1] (Dr. King) has succeeded in collecting and in presenting very lucidly an essentially complete account of the development of the telescope from its uncertain earliest beginnings to the 200-inch.[2] For the professional astronomer it has all the important facts of the world's great telescopes, the excellent index and the important references to the original papers. For the general reader it has an inspiring story of human progress. For the amateur telescope maker it will be an unending source of ideas.[3] Everyone who is interested in the history of the telescope is indebted to King for writing such a fine book . . . .[4]

456 pages; 103 halftones, 41 drawings, plus 52 diagrams. Extensive list of references with each chapter. **$12.50**

[1]E. Opik, *Irish Astronomical Journal.*
[2]Harlan J. Smith, *American Scientist.*
[3]John F. Heard, RASC *Journal.*
[4]Frank K. Edmondson, *Science.*

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not resulted in a completely unified point of view, with parts of the discussion more appropriate to a number of years ago, others to more recent times. An example of an older viewpoint is the statement that of two nuclear processes for generating energy in the sun—the carbon cycle and the direct conversion of hydrogen into helium—the former is by far the more probable. An example of a treatment that changes from paragraph to paragraph concerns the emission lines of the corona. At first these lines are presented as a mystery, but later it is suggested that they may be from forbidden transitions. Finally, the work of Edlén is presented, along with the usual table of coronal lines and the ions that produce them.

A most surprising recurring theme is the idea of the chemical stratification in the solar atmosphere under the combined influence of gravity and radiation pressure. Thus, the lower chromosphere is considered not only to be the source of emission lines from the metals but the place in which these metals are concentrated. Similarly, the heavy ions in the corona are supposedly concentrated in the very low part of the inner corona. Another unusual idea is that prominences are projections of the chromosphere upward, rather than clouds of coronal material that have been cooled and condensed by radiation.

In general, the discussions of observational material are quite good, of theoretical concepts not so good, and of apparatus sometimes good and sometimes only fair. The illustrations are excellent. I find the historical aspects of the book particularly pleasing. Abetti writes as a member of a line of illustrious Italian solar observers, beginning with Galileo and including Secchi. His extensive references to the work of his predecessors are interesting and enlightening.

I recommend the book for the general reader, for the student of general science or astronomy who wishes a more detailed discussion of the sun, and also for a newcomer in the field of solar physics as preparation for G. P. Kuiper's *The Sun* and the more specialized journal articles.

DONALD E. BILLINGS
High Altitude Observatory

DICTIONARY OF PHOTOGRAPHY

A. L. M. Sowerby, editor. Philosophical Library, New York, 1956. 719 pages. $10.00.

EVERY amateur astronomer would at some time like to record celestial objects on film or plate. Local drugstore processing of such films yields discouraging results, but it is easy for the amateur to do his own developing and printing to obtain pictures of high quality. With modern processing equipment, he can load the film by daylight into a light-tight tank, and pour in the developing solution, shortstop, and fixer. One unit now on the market can completely process a film, ready for the final washing, in only seven minutes.

Those who hesitate to begin astronomical photography will find encouragement in a reference book that explains in simple language the principles of lenses, films, and darkroom work. Such a book is the new 18th edition of the *Dictionary of Photography*, prepared by the editor of the British magazine *Amateur Photography*. Not a textbook, it has a wealth of information concisely arranged in dictionary form. Some of the terms included are British and not used in this country, but there are numbers of cross references to aid Americans. Certain chemicals required for some formulas are not well known in America, but fortunately the ingredients of the most widely used developers are standard in both countries.

Much interesting historical information is given. We read that the astronomer John Herschel (who also discovered hypo) invented a method of treating paper negatives to reverse them into positive prints. His century-old amphitype process has no use today, but it is curious to find that the reversal print was made by a heated iron pressing through a protecting blotter. At present, heat-development processes are being devised for metal and glass surfaces.

Only a little over two pages is specifically devoted to astronomical photography, but this is carefully prepared and valuable to a beginner. And a surprisingly large proportion of the articles have astronomical implications. Lenses, their aberrations, designs, and formulas are well covered. The clear explanation of shutters is particularly helpful, and there are 27 pages devoted to weights and measures.

Among the many developing methods presented, the two-bath or divided development described on page 321 is of special interest. Its principle is the separation of the developing agent from the chemicals that activate it. The film is immersed in the developing and stabilizing bath until the emulsion is saturated. Next the film goes into the activator for one to five minutes, while the development proceeds until all the developer that had been absorbed by the emulsion is exhausted.

Some experiments of mine at Harvard Observatory in 1949 gave most promising results with this method. It prevents overdevelopment, for once the chemical action halts in the second bath nothing further happens to the film. Another advantage is that the highlights develop first, and then stop, while the shadow detail keeps on working until the chemicals are exhausted. Very uniform development density and tonal scale are possible. The keeping properties of the solutions are excellent.

This book is of value to any amateur astronomer interested in photography, for it has the answers to many practical problems.

ROBERT E. COX

NEW BOOKS RECEIVED

THEORIES OF THE UNIVERSE: FROM BABYLONIAN MYTH TO MODERN SCIENCE, *Milton K. Munitz*, editor, 1957, *Free Press*. 437 pages. $6.50.

Selections from the writings of great astronomers afford the general reader a view into the history of man's wonderings and discoveries about the nature of the universe. Among the 31 writers represented are Ptolemy, Copernicus, Galileo, Kepler, Newton, Kant, William Herschel, Einstein, Hubble, and Hoyle.

THE NEXT FIFTY BILLION YEARS, *Kenneth Heuer*, 1957, *Viking*. 144 pages. $3.00.

Originally published in 1953 under the title, *The End of the World*, this science-fiction-type book has now been revised and rewritten. There are eight paintings by Chesley Bonestell included. (See *Sky and Telescope*, November, 1953, page 21.)

THE MODERN UNIVERSE, *Raymond A. Lyttleton*, 1956, *Harper*. 207 pages. $3.50.

In 1955, the author of this book gave a series of six television programs in Great Britain. He has now expanded the material into a popular survey of astronomy and its latest discoveries.

THE CONQUEST OF THE ANTARCTIC, *Norman Kemp*, 1957, *Philosophical Library*. 152 pages. $4.75.

In this readable account of the earth's least known continent, the author traces the history of recent expeditions to this barren wasteland. The final chapter tells of the programs different countries will undertake there during the International Geophysical Year.

THE HISTORY OF MATHEMATICS, *Joseph Ehrenfried Hofmann*, 1957, *Philosophical Library*. 132 pages. $4.75.

In this translation from the German, Professor Hofmann sketches the growth of mathematical techniques from prehistoric times to about A.D. 1650. Much space is devoted to medieval and Renaissance mathematics.

AN INTRODUCTION TO ASTRONOMY, *Robert H. Baker*, 1957, *Van Nostrand*. 333 pages. $4.85.

The fifth edition of this standard introductory textbook has been completely rewritten to include up-to-date information on the newest astronomical discoveries and interpretations, including findings with the 200-inch reflector and with radio telescopes.

WEATHER, *Paul E. Lehr, R. Will Burnett*, and *Herbert S. Zim*, 1957, *Simon and Schuster*. 160 pages. $1.95 cloth, $1.00 paper bound.

This is a simple, profusely illustrated summary of the weather, compiled by a meteorologist and two educators. The reader is shown how the earth's atmosphere is affected by the sun and by the movements of the earth, and is told something of the principles of forecasting.

OPTIQUE ASTRONOMIQUE, *M. Daisomont*, 1957, *Editions J. Duculot, S. A.*, Gemblaux, Belgium. 81 pages. 65 Belgian francs, paper bound.

Abbé Daisomont has written in French a brief introduction to astronomical optics. Intended to meet only the immediate needs of amateurs and beginners, the booklet ends with a long bibliography of optical books from eight countries.

REALITIES OF SPACE TRAVEL, *L. J. Carter*, editor, 1957, *Putnam and Co., Ltd.*, 42 Great Russell St., London W.C. 1, England. 431 pages. £1, 15s.

The 24 papers by 16 experts were originally presented to the British Interplanetary Society, and are here gathered to give recent views on travel in outer space and its problems.

OPTICS: THE SCIENCE OF VISION, *Vasco Ronchi*, 1957, *New York University Press*. 360 pages. $10.00.

The author is director of the National Institute of Optics, Arcetri, Italy, and famous for his invention of the Ronchi test for optical surfaces. In this book, summarizing 40 years of research in optics, he discusses the subject as it concerns the human eye. The translation is by Edward Rosen, of the College of the City of New York.

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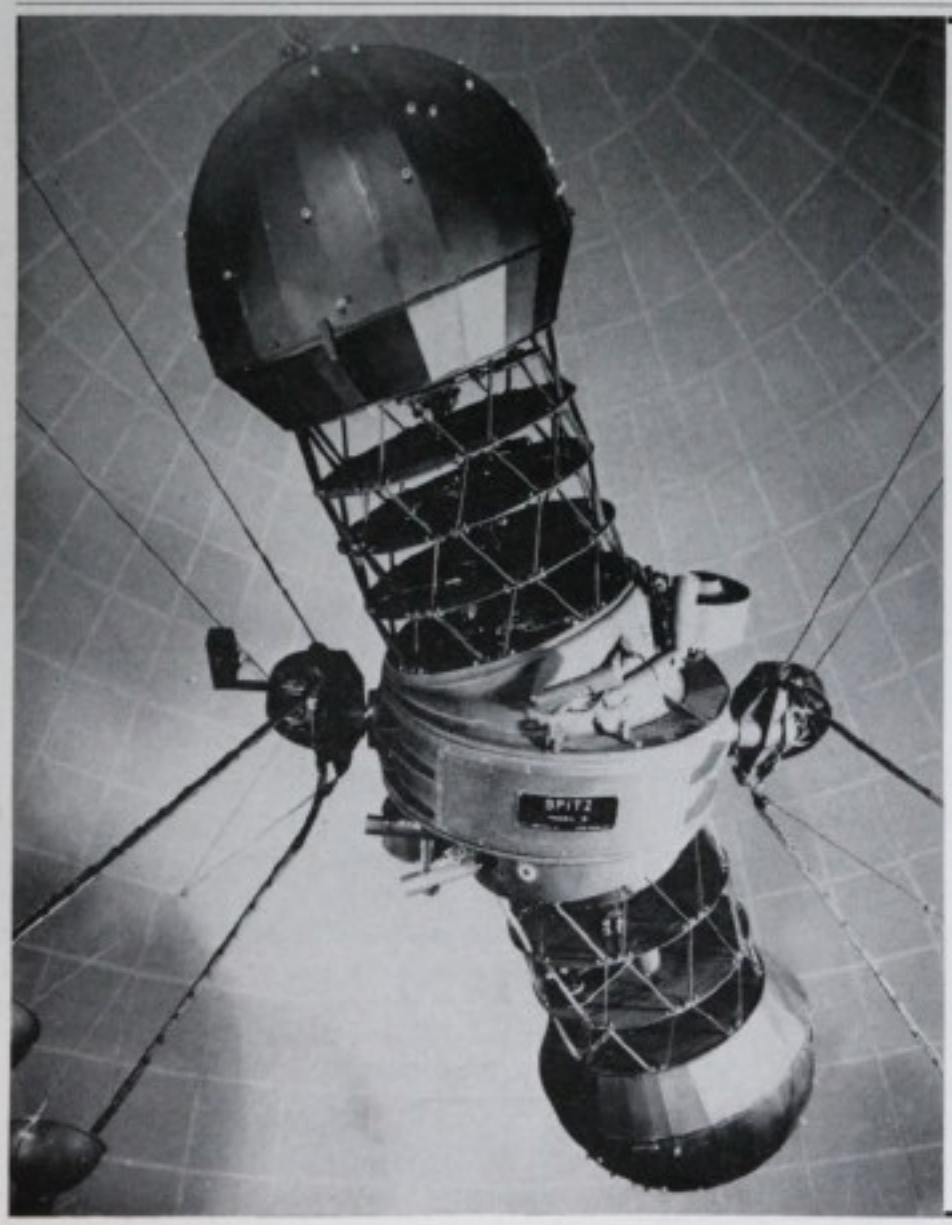

Spitz Laboratories is happy to announce the completion of the Major Planetarium for the new United States Air Force Academy at Colorado Springs, Colorado.

It has been inspected by Air Force Academy officials in the new planetarium chamber at Spitz Laboratories, Yorklyn, Delaware, and has also been viewed by planetarium directors, scientists, and educators from all parts of the country.

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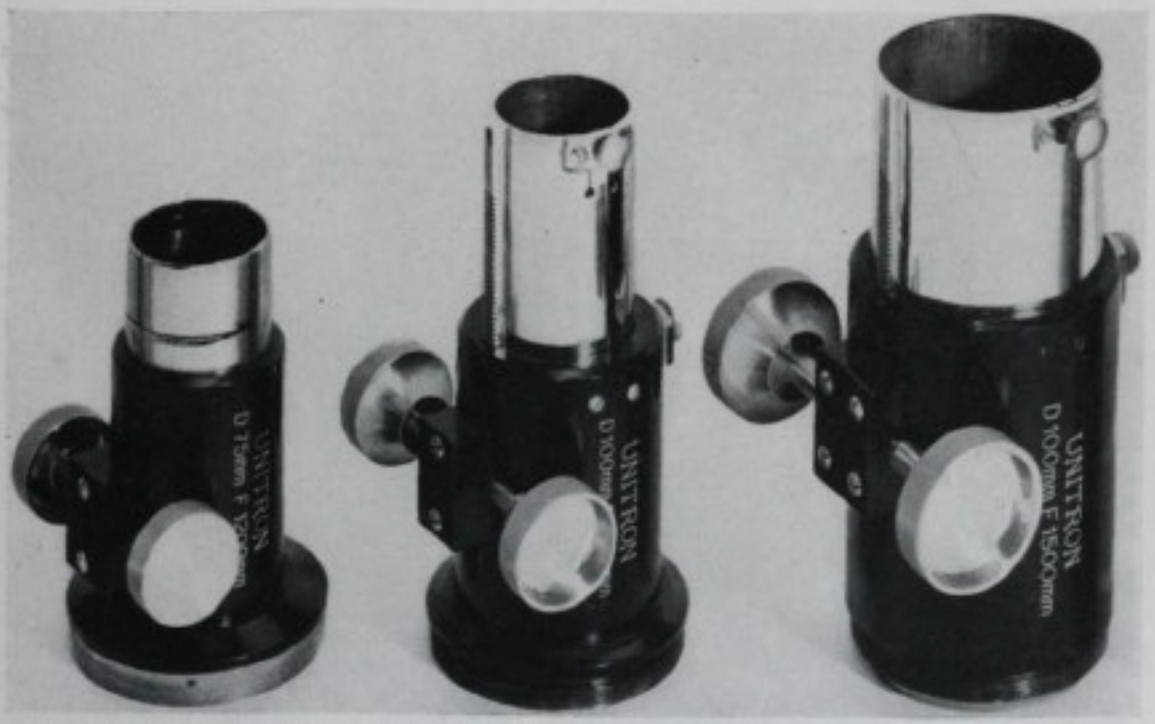

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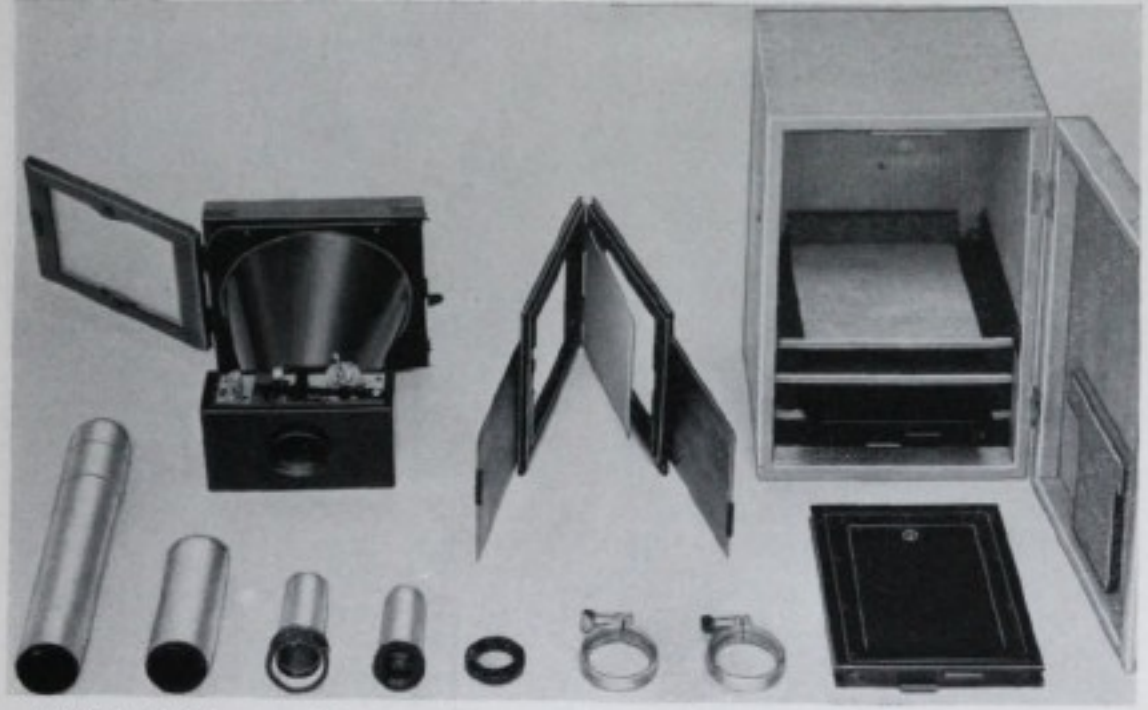

ASTRO-CAMERA 220. With the aid of this fine camera, owners of altazimuth models can photograph the sun, sunspots, the moon, and solar and lunar eclipses. An equatorial model is required for recording other celestial objects which need longer exposures, and the clock drive is essential for prolonged tracking. The camera uses an air-operated curtain shutter of the Thornton-Pickard type, giving speeds of 1/10 to 1/90 second in addition to bulb and time. The camera may be positioned so that the plane of the film passes through the focal point of the objective, which is then the only optical element. When magnification of the primary image is desired, an eyepiece can be inserted into the camera tube and an image projected on the film. Astro-Camera 220 comes complete with ground-glass back, 3 double plateholders for 3¼" x 4¼" plates or cut film, a 30-mm. f.l. eyepiece, extension tubes and clamps to lock the camera firmly in place, air-operated bulb release (not illustrated), removable filter, and a fitted wooden cabinet. Model A is designed to fit the UNITRON rack and pinion replacing the customary drawtube and is for UNITRONS only. Model B fits 1¼" eyepiece holders.

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Note on the UNITRON 6"

At the risk of inciting to riot the multitudes of eager customers waiting to purchase the new UNITRON 6" Refractor, we advise regretfully that the announcement of this model, originally scheduled for this month, must be postponed until the next issue. A few last-minute "extras" have been included, and sufficient time was not available to prepare up-to-date photographs. The suspense is terrific — but so is the telescope.

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Our kits have PYREX mirror blank, PYREX tool the same thickness, ample supply of optical quality abrasives, fast polishing cerium oxide, red rouge and pitch. Packed in metal cans.

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Kits include five abrasives with our special superfine finishing abrasive for superior fine grind, selected pitch, cerium oxide, pyrex mirror, and velvet-finishing tool (heat resistant, approximate hardness of pyrex). C.O.D.'s accepted.

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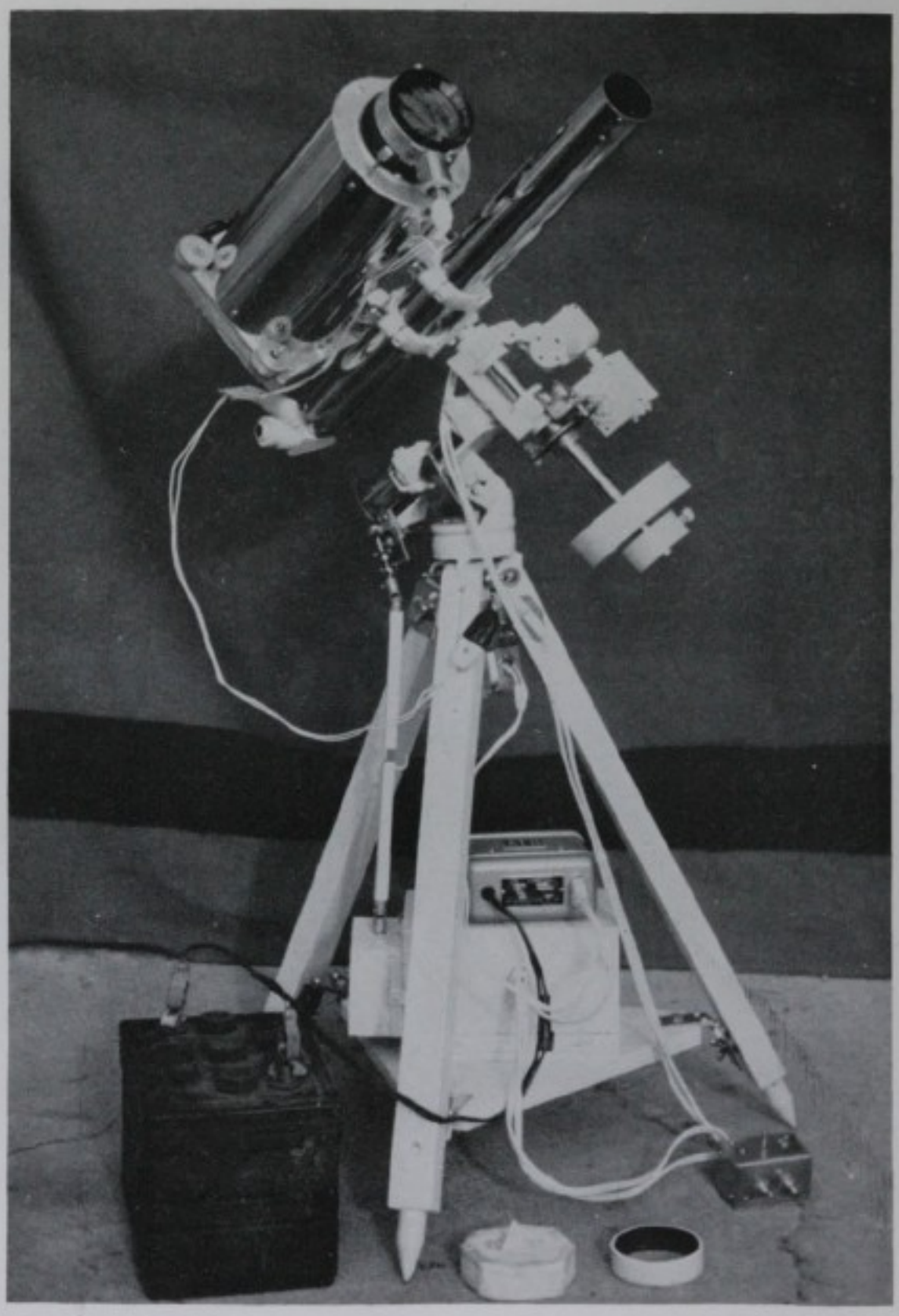
SUCCESSFUL PHOTOGRAPHY of the sky requires a good camera lens, guiding controls, a clock drive, a guide telescope of adequate focal length, and a sturdy mounting free from vibration. The apparatus pictured here was made with all these points in mind, and was provided with its own power supply so it may be taken anywhere for observing.

The camera lens, seen at the top left in the picture, is a Salmoiraghi, f/4.5, with a focal length of 12.4", but it is stopped down to f/5.6, resulting in an aperture of 2.2". A chrome-plated stovepipe forms the barrel of the camera, its upper end holding a wooden lens board on which the threaded lens flange is bolted. A hardwood 4-by-5 plateholder is at the other



The slow-motion control box for the Veio astronomical camera and its guide telescope can be seen at the base of the tripod on the right side of the picture. Electric control of the declination motion is provided to keep a guide star centered on the cross wires of the small telescope; this is especially valuable in a portable instrument, which is difficult to set up in perfect polar alignment.

Three Messier clusters are shown in Fredrick N. Veio's picture of Auriga: M37 near the left edge, M36 almost in the center of the field, and M38 in the upper right. This is a 2½-times enlargement of a 20-minute exposure at f/5.6. North is at the top.

end. The photographic plate covers a field of sky 17 by 21 degrees. Only a portion of this field is shown in the picture of the Auriga clusters reproduced above. Dewing of the lens is prevented by a light bulb wrapped in brass foil, held in a tube just below and against the lens barrel.

For this camera scale, the 2-inch guiding telescope, with a focal length of 23½", is adequate. The eyepiece gives 30 power, and the reticle is illuminated. The brass tubing of the guiding telescope supports the camera and is itself strapped to the equatorial mounting.

Stainless steel axles, ¾" in diameter, are set in cast-iron bearings, which were welded to ¼" boiler plate by my brother Jerry. Brass flanges are threaded onto the axle ends, and the bearing flanges are bolted to them.

The declination 24-volt reversible motor is connected to a war-surplus 48:1 worm-and-gear unit, and this is linked to the worm of a 96-tooth gear. A rheostat slows the motor down to 12 r.p.m., and backlash is taken up in two seconds when the direction of slow motion in declination is reversed.

A 7-watt 1-r.p.m. synchronous motor is used for the main drive in right ascension; this motor is housed in the box bolted on the platform between the tripod legs. On the 7-watt output axle is a 3-watt synchronous motor, 1 r.p.m., which has its output axle connected to a 15:1 worm-and-gear unit. The latter is united to miter gears which are attached to the worm of the 96-tooth gear on the friction clutch at the end of the polar axle.

The 3-watt motor revolves in the same direction as the 7-watt; therefore there is no backlash. The 3-watt is turned on briefly to speed up the guide star on the reticle of the guiding telescope, and the 7-watt is turned off briefly to slow down the guide star. These slow-motion controls work very well, and permit successful photography.

The storage battery's 6-volt current is changed to 110-volt a.c. by a converter. This current goes to the motor box for

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State size of tube, up to 12". Tripod not included.
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Without circles ..... **$96.00** f.o.b. Arvada

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	Aluminum	*Brass*
5" circles, set of two	**$12.00**	**$15.60**
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The Barlow gives magnification up to slightly over three times that of the ocular alone. It is achromatic, coated, and mounted to the U. S. standard size of 1.250 inches.

The modified Erfle eyepiece has a field of 75 degrees with excellent eye relief. The combination gives the equivalent focal length of slightly under 6 mm. Many users state it is far superior to any shorter focal length ocular of equivalent magnification.

The Barlow sells for $16.00 postpaid, and the Erfle for $14.75 postpaid. Both are guaranteed to perform as stated above or money refunded.

ORTHOSCOPIC OCULARS—All hard coated, standard 1¼-inch outside diameter.

28-mm.	$15.00	10.5-mm.	$16.25	4-mm.	$17.25
16.3-mm. (Erfle)	$14.75	7-mm.	$17.25	Barlow 3x	$16.00

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Warranted to equal or surpass any oculars obtainable anywhere or money refunded.

Finished mirrors, mirror kits, spiders, elliptical flats, focusing devices, aluminizing.

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Sharper images, wider field, more light at higher powers! A startling statement positively proven in 16-page telescopic educational matter sent free on receipt of self-addressed long envelope bearing nine cents (9c) return postage.

First, the Goodwin Resolving Power lens placed in front of eyepiece gives three times the magnification on each by lengthening your primary focal length angle up to three times, yet extends eyepiece out no more than two inches from normal. This alone sharpens definition.

Next, by achieving your highest powers on more comfortable low-power eyepieces, you lessen image deteriorations due to short-focus acute bending of the convergent beam, since all usual eyepieces are f/1 or less. Again sharper images from this highest precision lens.

Third, you get greater illumination and wider field by relieving tiny aperture restrictions of higher-power eyepieces.

The Resolving Power lens is achromatic, coated, gives flat field sharp to the edge. Here is astonishment! Price $17.50 in 4" long adapter tube fitting standard 1¼" eyepiece holders ONLY (also adaptable to Unitrons. State if Unitron). Money back if not positively thrilled after two weeks trial! Used and praised by legions!

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the two right ascension motors and to a transformer beneath the tripod head; the latter has 8- and 24-volt outlets for the light bulbs and the reversible declination motor.

It takes about 30 minutes to set up the 52-pound instrument. The rear leg of the tripod in the picture can be extended to accommodate gently sloping land.

My cash outlay was $192, but the camera lens was given to me in exchange for 100 hours of gardening labor.

FREDRICK N. VEIO
317 San Carlos Ave.
Piedmont 11, Calif.

TESTING UNCOATED MIRRORS ON DOUBLE STARS

MANY telescope makers who figure their mirrors by the Foucault knife-edge method would also like to test them on the stars. But often they hear that an uncoated mirror can be used only to observe such bright objects as the sun and moon. Nevertheless, with an unaluminized mirror, the images of bright single and double stars can be examined.

Assuming that an uncoated mirror reflects four per cent of the incident starlight, and that a 1-inch refractor can show stars of magnitude 9.0, we may compute that a 4-inch mirror should reveal 8.5-magnitude stars, a 6-inch 9.4, an 8-inch 10.0, and a 10-inch 10.5. Thus, the stars will appear about 3½ magnitudes fainter than in an aluminized mirror. With this loss of light, only relatively low powers can be used.

Among the most suitable test objects are Epsilon Lyrae (the famous double-double) and Castor (Alpha Geminorum), one or the other always being above the horizon for northern observers. Epsilon[1] consists of two stars of magnitude 4.6 and 6.3, separated by 2.5 seconds of arc; Epsilon[2] has components of magnitude 4.9 and 5.2, now 1.9 seconds apart. The bright stars of the Castor system, magnitudes 2.0 and 2.8, are now separated by 2.2 seconds.

My experience indicates that if these pairs can be split at 100x with an uncoated 6-inch mirror, the same mirror after being coated with aluminum will get very close to the Dawes limit, at perhaps 360x. But that high a power cannot be used without a reflecting coat, because the available light would be spread out too thinly in the magnified star disks.

Many amateurs study star diffraction rings inside and outside of focus as a check on their Foucault testing of the mirror's final figure. Even with an uncoated mirror, if the sky is really dark, careful examination may show these rings for the brightest stars, especially Sirius and Canopus.

H. T. SHERMAN
216 Otis
St. Paul, Minn.

ASTROLA Reflecting Telescopes

AMERICAN MADE

STANDARD MODEL "A", 6-inch	**$295.00**
STANDARD MODEL "B", 8-inch	**$375.00**
STANDARD MODEL "C", 10-inch	**$475.00**

The above instruments are fully portable — as they can be assembled or taken down in three minutes. Each comes with three of the finest oculars. The equatorial head and stand are of cast aluminum; the tube is of fiberglass. Optics are corrected to ⅛ wave or better and are quartz coated. Clock drives, rotating tubes, setting circles furnished at additional cost.

Pyrex mirrors with diagonals are sold separately if desired:

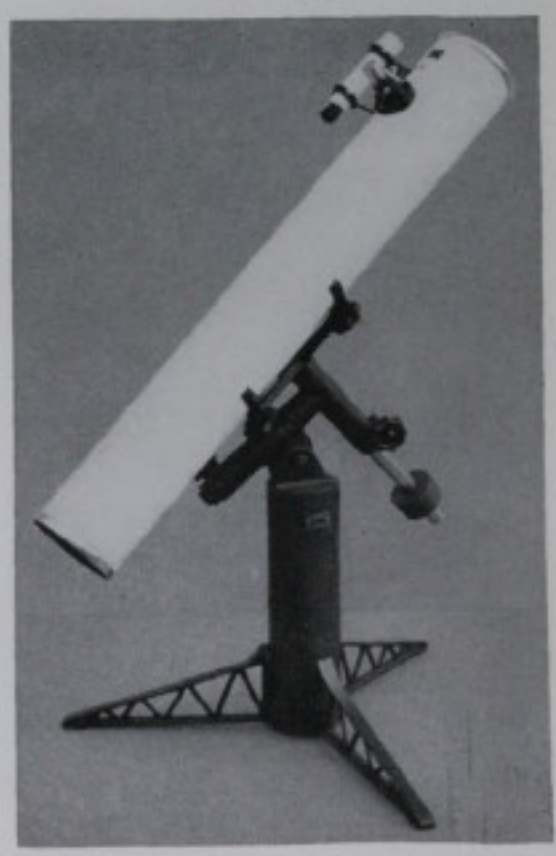
6" with diagonal — aluminized and quartz coated	**$ 60.00**
8" with diagonal — as above	**$ 92.50**
10" with diagonal — as above	**$160.00**

The ASTROLA telescopes will resolve double stars to the Dawes limit. If you are not satisfied with the performance of the mirror in your present telescope, we will refigure, aluminize, and coat it at a reasonable price.

All prices F.O.B. our plant, Long Beach, Calif., and subject to change without notice.

CAVE OPTICAL COMPANY

4137 E. Anaheim St., Long Beach 4, Calif.



Standard Model "A" 6-inch ASTROLA, f/8, complete with 3 oculars (72x, 180x, 315x)
$295.00

AIRSPACED OBJECTIVES

MOUNTED IN ALUMINUM CELLS f/15

We offer the lowest priced, hand-corrected, precision, American-made astronomical objective, *mounted in a black anodized aluminum cell.* Our reputation has been established over the years as the most reliable source of high quality astronomical lenses.

"Those in the know" BUY FROM US BECAUSE:

Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines, as is usual for visual refractors. The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" f.l. (uncoated).. **$28.00**
Same as above with coating.... **$32.00**
4⅛" diam., 62" f.l. (uncoated).. **$60.00**
Same as above with coating.... **$69.00**

We can supply ALUMINUM TUBING for the above lenses.

"BIG" ACHROMATIC TELESCOPE OBJECTIVES

We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	254 mm (10").....	$12.50	83 mm (3¼")	660 mm (26").....	$28.00
54 mm (2⅛")	300 mm (11.8").....	12.50	83 mm (3¼")	711 mm (28").....	28.00
54 mm (2⅛")	330 mm (13").....	12.50	83 mm (3¼")	762 mm (30").....	28.00
54 mm (2⅛")	390 mm (15.4").....	9.75	83 mm (3¼")	876 mm (34½").....	28.00
54 mm (2⅛")	508 mm (20").....	12.50	83 mm (3¼")	1016 mm (40").....	30.00
54 mm (2⅛")	600 mm (23½").....	12.50	102 mm (4")	876 mm (34½").....	60.00
54 mm (2⅛")	762 mm (30").....	12.50	108 mm (4¼")	914 mm (36").....	60.00
54 mm (2⅛")	1016 mm (40").....	12.50	110 mm (4⅜")*	1069 mm (42⅛").....	60.00
54 mm (2⅛")	1270 mm (50").....	12.50	110 mm (4⅜")	1069 mm (42⅛").....	67.00
78 mm (3⅛")	381 mm (15").....	21.00	128 mm (5⅛")*	628 mm (24¾").....	75.00
80 mm (3⅛")	495 mm (19½").....	28.00	128 mm (5⅛")	628 mm (24¾").....	85.00
81 mm (3⅜")	622 mm (24½").....	22.50	*Not coated		

● We can supply ALUMINUM TUBING for the above lenses. ●

COATED BINOCULARS

American Type "Zeiss" Type

Beautiful imported binoculars, precision made, at a low, low price. Above we have pictured the two most popular types. The American type offers a superior one-piece frame and a clean design, pleasing to the eye. Complete with carrying case and straps. **Price plus 10% Federal tax.**

SIZE	TYPE	C. FOCUS	IND. FOCUS
6 x 15	OPERA	—	$12.75
6 x 30	"ZEISS"	$18.75	16.75
7 x 35	"ZEISS"	21.25	19.25
7 x 35	AMERICAN	23.50	—
7 x 35	AMERICAN WIDE ANGLE 10°	37.50	—
7 x 50	"ZEISS"	24.95	22.50
7 x 50	AMERICAN	32.50	—
8 x 30	"ZEISS"	21.00	18.25
10 x 50	"ZEISS"	30.75	28.50
20 x 50	"ZEISS"	41.50	39.50

MONOCULARS

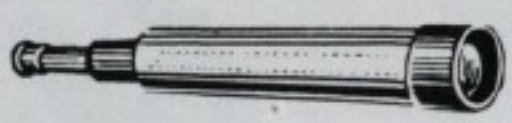
Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	$10.00	7 x 50	$15.00
8 x 30	11.25	16 x 50	17.50
7 x 35	12.50	20 x 50	20.00

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

"GIANT" 3" TELESCOPE



40 power Special Price **$57.50**

You rarely find an instrument like this offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle-sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image—it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

"GIANT" EYEPIECE

WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1 13/16" aperture. **$12.50**

WIDE ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field... **$18.50**

1¼" Diam. Adapter for above eyepieces. **$3.95**

LENS CLEANING TISSUE — Here is a wonderful Gov't. surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications.

500 sheets size 7½" x 11"..... **$1.00**

MOUNTED EYEPIECES

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
12.5 mm (½")	Symmetrical.....	$ 6.00
16 mm (⅝")	Erfle (wide angle).....	12.50
16 mm (⅝")	Triplet.....	12.50
18 mm (¾")	Symmetrical.....	6.00
22 mm (27/32")	Kellner.....	6.00
32 mm (1⅛")	Orthoscopic.....	12.50
35 mm (1⅜")	Symmetrical.....	8.00
55 mm (2 13/16")	Kellner.....	6.00

COATED 75 cents extra.

ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3 3/16"	42"	$ 9.75
Pyrex	4¼"	45"	$13.50
Pyrex	6"	60"	$25.00

AN ECONOMICAL EYEPIECE

This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube..... **$4.50**

Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼"	2⅛"	$1.20
3⅛"	3¼"	1.75
4½"	4⅜"	2.75
5"	4⅞"	2.75

All tubing is shipped POSTPAID.

Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

For 2⅛" I.D. Tubing	Postpaid	$12.95
For 3¼" I.D. Tubing	"	12.95
For 4⅜" I.D. Tubing	"	12.95

REFLECTOR TYPE FOR ALL SIZE TUBING:
Complete with diagonal holder..... $ 9.95

Aluminum Lens Cells Black Anodized

Cell for Lenses	Cell Fits Tubing	Price
54 mm Diam.	2⅛" I.D.	$ 3.50
78 mm "	3¼" "	6.50
81 mm "	3¼" "	6.50
83 mm "	3¼" "	6.50
110 mm "	4⅜" "	10.50

3X TELESCOPE

Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, wt. 2 lbs.

Gov't. Cost $200. **$9.75**

FIRST-SURFACE MIRRORS

Size	Thickness	Postpaid
14" x 16"	¾"	$10.00
8" x 10"	¼"	4.25
4" x 5"	⅛"	1.85
4" x 4"	⅛"	1.50
1¼" x 1½"	1/16"	.25

RIGHT-ANGLE PRISMS

8 mm face.....ea.	$ .75	28 mm face.....ea.	$1.75
12 mm face.....ea.	.75	38 mm face.....ea.	2.00
23 mm face.....ea.	1.25	47 mm face.....ea.	3.00

A. JAEGERS • THE GLASS HOUSE • 691 S MERRICK RD. LYNBROOK, N.Y.

3″ ASTRONOMICAL REFRACTOR TELESCOPE

A good-looking, complete instrument, ready to use. Reveals the wonders of the sky in sharp, clear detail. The 3″ air-spaced achromatic objective (low-reflection coated) has been tested by experienced observers who pronounce it equal to any you can buy at reasonable cost. An excellent telescope at an amazingly low price. Rack-and-pinion eyepiece holder of cast aluminum—focusing tube of chrome-plated brass. Takes standard 1¼″ eyepieces. We supply two eyepieces and a Barlow lens, giving powers of 40X, 90X, 120X, 270X. Star diagonal for easy viewing. Optical finder telescope, 6-power, with crosslines. Hardwood tripod, 60″ long. Equatorial mounting makes following a star very easy. FREE STAR CHART AND STAR BOOK INCLUDED.

Stock #85,032-Y ..... **$125.00** f.o.b.
(Shipping wt. 30 lbs.) Barrington, N. J.

3″ "PALOMAR, JR." REFLECTOR

60- to 120-Power — An Unusual Buy!

Assembled—ready to use! See Saturn's rings, the planet Mars, huge craters on the moon, star clusters, moons of Jupiter, galaxies! Nonbreakable aluminum-covered tube. Equatorial mount with lock on both axes. Aluminized and over-coated 3″ diameter f/10 primary mirror, ventilated cell. Telescope comes equipped with a 60X eyepiece and a mounted Barlow lens, giving you 60 to 120 power. A finder telescope, always so essential, included. Sturdy, hardwood, portable tripod.

Free with scope: Valuable STAR CHART and 136-page book, "Discover the Stars."

Stock #85,050-Y ..... **$29.50** f.o.b.
(Shipping wt. 10 lbs.) Barrington, N. J.

SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope—by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36″ high on removable legs. Adjustable 3″ polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle—swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

Stock #70,068-Y ..... **$14.95 ppd.**

4″ REFRACTOR TELESCOPE

240-POWER

Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

Our newest development. Built for rugged use, quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60″ hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4″ objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4″ refractor of comparable quality is over $400, so our new model saves you almost 40%.

Stock #85,038-Y ..... **$247.00** f.o.b.
(Shipping wt. 55 lbs.) Barrington, N. J.

LOW-COST TRIPOD AND ALTAZIMUTH MOUNT

Put your telescope to use as soon as it's finished, by using this mount. Later you can remove the offset yoke and bolt an equatorial mounting of pipe fittings or other parts to the tripod head. Or, if you don't need a portable telescope, buy only the offset yoke to bolt to a post in the ground. Takes tubing up to 7½″ outside diameter. The yoke is made of ¼″-thick painted steel plate. The tripod head is machined cast iron, 6½″ diameter, gray wrinkle. The three sturdy hardwood legs are 32″ long.

Tripod and Offset Yoke
Stock #85,037-Y **$19.95**

Offset Yoke only
Stock #85,042-Y **$9.95**

Tripod Head and Legs only
Stock #85,043-Y **$12.50**

All above items are f.o.b. Barrington, N. J.

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼″, standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y ..... **$7.95 ppd.**

EDSCORP SATELLITE TELESCOPE

THE STORY: From the beginning of the visual satellite program, Edmund Scientific Co. was consulted by the Coordinator of Visual Satellite Observations of the Smithsonian Astrophysical Observatory in order to find existing optical instruments or to help in the development of new ones to meet the unique requirements of MOONWATCH. Every effort was to be made to get an instrument with the greatest possible field, which would still have the ability to observe faint objects with only moderate magnification. All this was to be provided at a minimum cost. More than thirty different optical arrangements were examined and evaluated by expert advisors to the MOONWATCH program. The optics which we have used have been described in the *Bulletin for Visual Observers of Satellites* as providing one of the best combinations for the purpose.

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide-field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

MOUNT: The mount came in for special attention because of unique requirements of group observing. The center of rotation of the instrument is just below the point where the optical axis is deflected by the front-surface mirror. The mirror is set at 45° to the axis of the telescope barrel and reflects light at exactly 90°. Side brackets and wing nuts permit fast, easy elevation and rigid locking. Rubber eyeguards and the angle of the telescope permit the greatest comfort in long-time viewing. The wide field and our special mount permit the utmost coverage of the possible passage of the satellite, without omission of an area of the sky, by a string of observers.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount. Stock No. 70,079-Y—$9.95. **2.** Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y—$3.95, which gives you an O.D. of 1¼″. This eyepiece cost the government $56.00! **3.** Makes a wonderful comet seeker; see complete asterisms. **4.** Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

Especially Made for Members of MOONWATCH
Stock #70,074-Y ..... **$49.50 ppd.**

ATTENTION!

Here's an Interesting "Do-It-Yourself" Project

If you want to build your own Satellite Scope, we can supply the optical parts, or any metal parts from our assembled Satellite Scope. We'll be glad to send you full descriptions of these components together with price information.

WRITE FOR SATELLITE BULLETIN #40-Y

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞″	5¼″	46″	Spiral-wound paper	$2.50
85,008-Y	6⅞″	7¼″	60″	Spiral-wound paper	4.00
85,011-Y	2⅞″	3″	48″	Aluminum	6.00
85,012-Y	3⅞″	4″	60″	Aluminum	8.75
85,013-Y	4⅞″	5″	48″	Aluminum	9.00
85,014-Y	6⅞″	7″	60″	Aluminum	15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

WAR-SURPLUS KELLNER EYEPIECE

Mounted — Ready to Use — 1¼" Outside Diameter — Coated — 1¼" Focal Length

Consists of an achromatic eye lens and an achromatic doublet field lens (Gov't. cost about $30). The clear aperture of the lenses is approximately 1", giving wide exit pupil and a clear image. Excellent for any telescope when low power and a wide field are needed. Try it for 10 days — if you don't agree that the performance is better than any commercial type selling for two or three times our price, we will refund your money in full.

Stock #50,130-Y ..... $5.90 ppd.

Rack & Pinion Eyepiece Mounts

For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅛" I.D. and our 3⅛" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅛" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅛" I.D. tubing) 13.95 ppd.

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAMETER
6-mm. (¼") Focal Length
Stock #30,063-Y ..... $8.50 ppd.

12.5-mm. (½") Focal Length
Stock #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y ..... $9.00 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

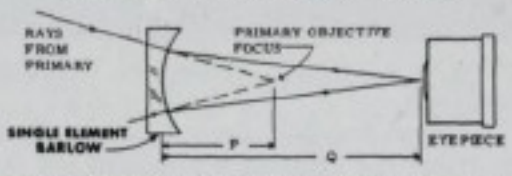
Stock #50,080-Y Finder alone, less ring mounts $9.95
Stock #50,075-Y Ring mounts per pr. $3.95

HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6"-8" REFLECTING TELESCOPE

Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1¾" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 3" to 10" tubes. Beautifully finished in baked black wrinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

Stock #85,023-Y ..... $49.50 f.o.b.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!

Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of —1⅝". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens $8.00 ppd.

ATTENTION — BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. Our first shipment is in. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diameter (1¼"), F. L. 31". (Will get 62X with ½" eyepiece; 124X with ¼" eyepiece.)
Stock #30,201-Y ..... $2.50 ppd.

ACHROMATIC OBJECTIVE, 42-mm. diameter (1-21/32"), F.L. 41". (Will get 41X with 1" eyepiece; 82X with ½"; and 164X with ¼".)
Stock #30,202-Y ..... $4.00 ppd.

UNMOUNTED SETS OF RAMSDEN EYEPIECE LENSES
Stock #30,210-Y ..... ½" eyepiece set $1.50
Stock #30,208-Y ..... ¼" eyepiece set $1.75

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead on refractor telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y ..... $12.00 ppd.

FUN WITH OPTICS

New booklet, 32 pages. Completely illustrated. Shows you how to build many types of optical instruments; plus lens primer showing various types of lenses and how they work, optical illusions, etc.

Simple, easy-to-follow directions for building astronomical telescopes, terrestrial telescopes, artist's drawing projectors, reflex slide viewers, magnifiers, miniature monoculars, transparency projectors and many other optical instruments.

No technical knowledge is needed. Youngsters or grownups can have a lot of fun learning about optics and building their own optical instruments using lenses, prisms, etc., purchased from us.

Stock #9050-Y ..... $.50 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... $16.25 ppd.

6X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y ..... $8.00 ppd.

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.
Stock #30,189-Y ..... $6.00 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18-mm. x 30-mm. — flat to ¼ wave length.
Stock #30,143-Y ..... $8.25 ppd.

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16".
Stock #40,165-Y ..... $1.75 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BE SURE TO GET FREE CATALOG "Y"
Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

Build Your Own Telescope

QUALITY KITS

We carry a full stock of eyepieces, prisms, mirror cells, eyepiece holders, finders, and mountings.

COMPLETE MIRROR REFIGURING SERVICE
NO CHARGE FOR TESTING YOUR MIRROR
Mirrors ground to order.

ALUMINIZING
with extra hard quartz coating.

FREE Catalogue. Instructions, 10¢.

GARTH OPTICAL COMPANY
Box 991 Springfield 1, Mass.

FIBERGLASS TUBES

- Light weight
- Reinforced
- Seamless
- Low thermal conductivity
- Rigid strength
- Perfectly round

Also presenting sun projectors of advanced styling.
(Patent pending)

W. R. PARKS
7307 Hillrose
Tujunga, Calif.

ALUMINIZING
ALUMINUM OVERCOATED
CHROMIUM ALLOY

★★★ **BERAL COATINGS** ★★★

The ideal coating for front surface **precision** mirrors for these reasons:
1. Beral has HIGH reflectivity.
2. Beral is HARD; does not sleek easily.
3. Beral can be cleaned easily — no porous OVERCOATING of quartz.
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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

DEEP-SKY WONDERS

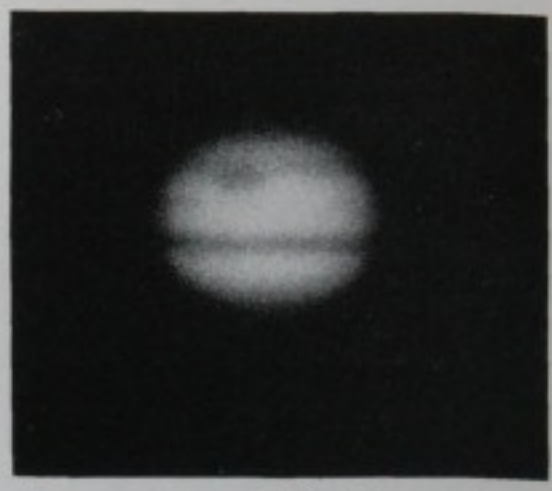
IN the constellation Canes Venatici, not far from the galaxy M51 described last month, lies another fine spiral, Messier 63. Overshadowed by its famous neighbor, M63 might have been as well known as M64 in Coma or M104 in Virgo, but, filed and forgotten under the curve of the Big Dipper's handle, it has not been mentioned in this department for about 10 years.

Yet M63 (NGC 5055) is easily found at $13^h\ 13^m.5$, $+42°\ 17'$ (1950); it lies about five degrees from the star Cor Caroli, in the direction of Eta Ursae Majoris. This galaxy is some 8′ by 3′ in size, and obviously spindle-shaped. Visible in a 3-inch telescope at magnitude 10, it brightens toward the center, and appears to swim as a celestial diatom in the dark night sky.

Admiral Smyth's classic *Celestial Cycle* describes the brighter wonders of the sky as viewed in his 6-inch refractor more than a century ago. In his book he notes M63 as of a milky-white tint, with a central nucleus resembling a small star.

About 9′ west and slightly north of M63 is a 9th-magnitude star, noted by Messier when he was examining this galaxy in 1779. East of M63 d'Arrest recorded a faint double star, when he observed with the 10-inch refractor at Copenhagen in 1864. On the photograph shown below taken by James Keeler at Lick Observatory, this object is a triple star.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.



Compare Mr. Acfield's photograph of Jupiter with that on the facing page.

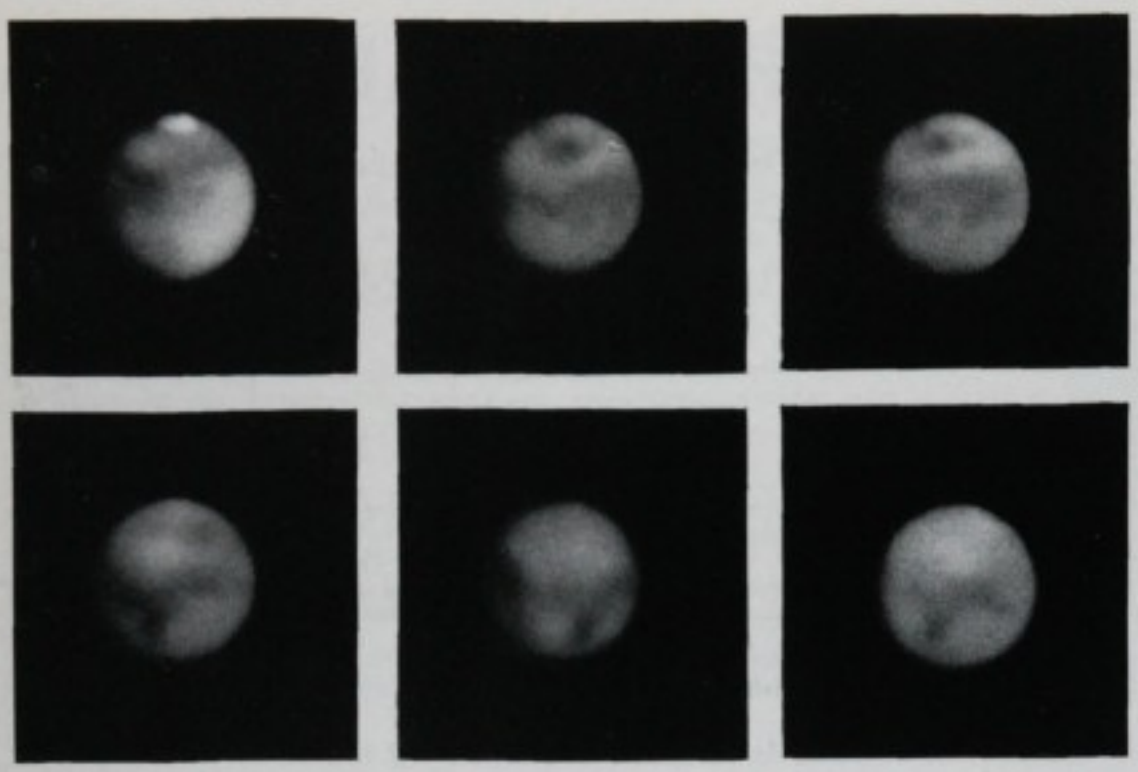
JUPITER IN 1957

With only one really prominent belt, Jupiter has a new look this year, and its great red spot appears more colorful than the writer has seen it during more than 30 years. The accompanying photograph illustrates these points, even though it was made under the trying conditions in the vicinity of a large city.

I used a Kodak 0.250 Ortho plate, exposure three seconds for an image three millimeters in diameter; it was projected through a ¾-inch eyepiece on a 10-inch f/9 reflector. The picture was taken on March 3, 1957, at 1:00 UT, the central meridian longitudes on the planet being 133°.4 for System I, 317°.1 for System II.

FRANK J. ACFIELD
Forest Hall Observatory
Northumberland, England

The general visual appearance of spiral galaxy M63 is shown by this 36-inch Crossley photograph, taken on July 5, 1902, by J. E. Keeler, exposure time 3½ hours, enlargement 3.3 times. South is at the top, west to the left. From Vol. 8 of the "Publications" of Lick Observatory.



Six photographs of Mars taken by J. H. Botham. Notice the rotation of the planet shown in pictures 2, 3, 5, and 6. Since south is at the top, corresponding to the view in an astronomical telescope, the rotation is from right to left.

SOUTH AFRICAN PHOTOGRAPHS

The 9-inch Grubb refractor of the Union Observatory, Johannesburg, South Africa, was used to obtain the accompanying photographs of Jupiter and Mars, all taken in yellow light. The one of Jupiter was made March 8, 1956, at 20:00 Universal time, on 35-mm. Ilford H.P. 3 film with an exposure of one second.

The six photographs of Mars were taken on Adox KB14 35-mm. film with exposures of 1½ seconds. This moderately high-speed film has a very thin emulsion which reduces internal light scattering, thus allowing the recording of fine details. In the table are given the order of the photographs, date (1956), Universal time, and longitude of the Martian central meridian.

No.	*Date*	*Time*	*C.M.*
1	Aug. 25	22:50	62°
2	Aug. 31	21:00	341°
3	Aug. 31	22:35	4°
4	Sept. 4	20:53	304°
5	Sept. 7	20:22	270°
6	Sept. 7	22:24	300°

J. H. BOTHAM
94 Ascot Rd., Judith's Paarl
Johannesburg, South Africa

Jupiter on March 8, 1956, at 20:00 UT. South is at the top. The great red spot hollow is prominent in the upper left.

Another New Slide Set

You'll now want this new slide set (we offered Slide Set 11 last month) for your collection. Each of the 24 slides is glass-mounted and ready for your projector.

Slide Set 12

Slides 265 through 281 are from the Georgetown Observatory atlas of the southern Milky Way. Each covers 16 square degrees, and the co-ordinates listed are the center of each frame. *a* is galactic longitude, and *b* is galactic latitude, the co-ordinates used for the Milky Way.

No.	*a*	*b*	*No.*	*a*	*b*
265	206°	−1°	274	263°	−1°
266	213°	−11°	275	375°	+1°
267	221°	−2°	276	375°	−11°
268	230°	+12°	277	286°	+1°
269	235°	+1°	278	292°	+14°
270	241°	−10°	279	296°	−12°
271	246°	+12°	280	301°	+1°
272	252°	−1°	281	316°	0
273	256°	−13°			

282—Spiral nebula NGC 5236 (M83)
283—Planetary nebula NGC 3242 in Hydra
284—Globular cluster NGC 6656 (M22) in Sagittarius
285—Diffuse nebula NGC 6523 (M8) in Sagittarius
286—Open cluster NGC 2437 (M46) in Puppis
287—Loose cluster NGC 6705 (M11) in Scutum
288—Globular cluster distribution in Sagittarius

24 slides **$9.75**

See last month's ad for listing of Slide Set 11 of southern sky objects. You'll want both of these sets, so order now and avoid disappointment as we expect many purchases.

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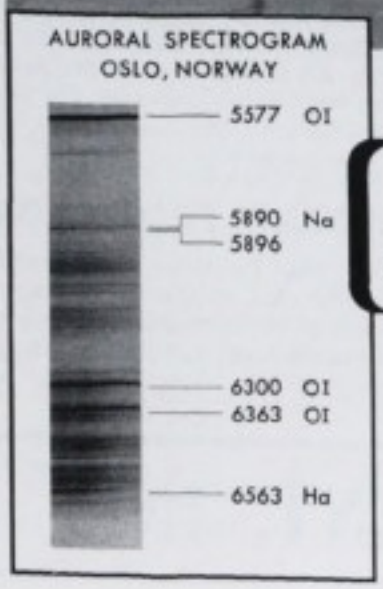
Dr. D. K. Berkey, Dept. of Physics and Astronomy, Colgate University, used spectrograph around B&L grating to record auroral spectra (Left) in Oslo, Norway.



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20 mm.	81x
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6.6 mm.	246x

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After many samples had been submitted and evaluated, we finally decided on one ocular — the ORTHO-STAR — which is now made exclusively for us. These fine eyepieces are presented for your approval.

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HOW TO ENTER THIS CONTEST: If you have an outstanding picture taken through your own telescope, send it to Coast Instrument, Inc., along with two verifying statements from friends. Pictures are judged on merit, with allowance for the kind of equipment — state size and type of instrument and camera used, and your age. If possible, include a picture of yourself and telescope. Entry must be received by the 15th of the month. Reentries invited. All pictures become our property, and cannot be returned. For more details, see page 188 of the February issue.

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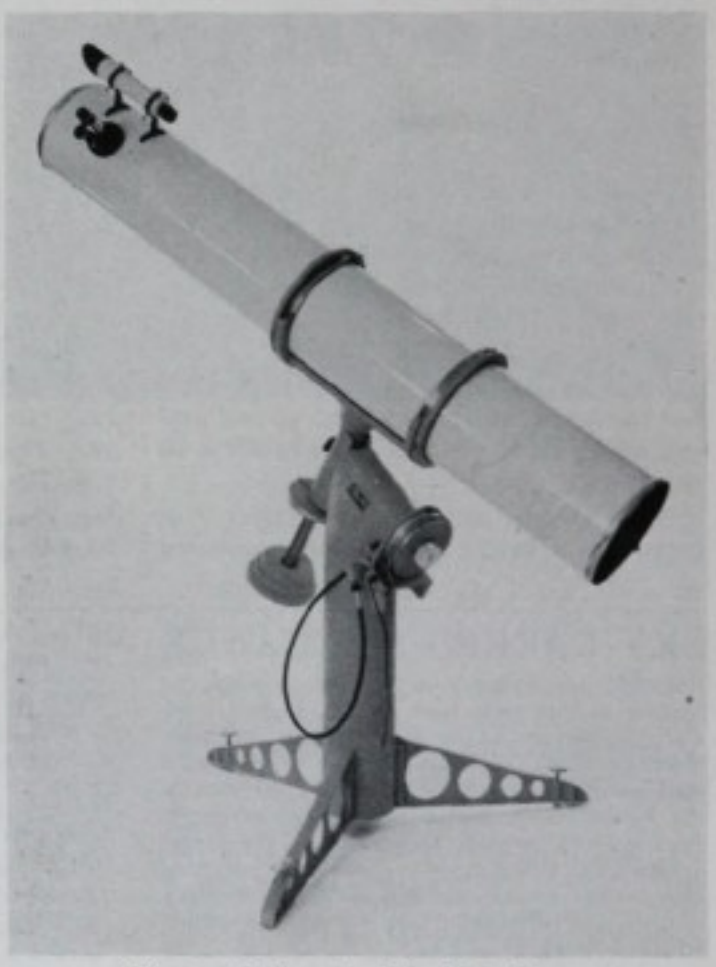

Illustrated above is 8-inch De Luxe.

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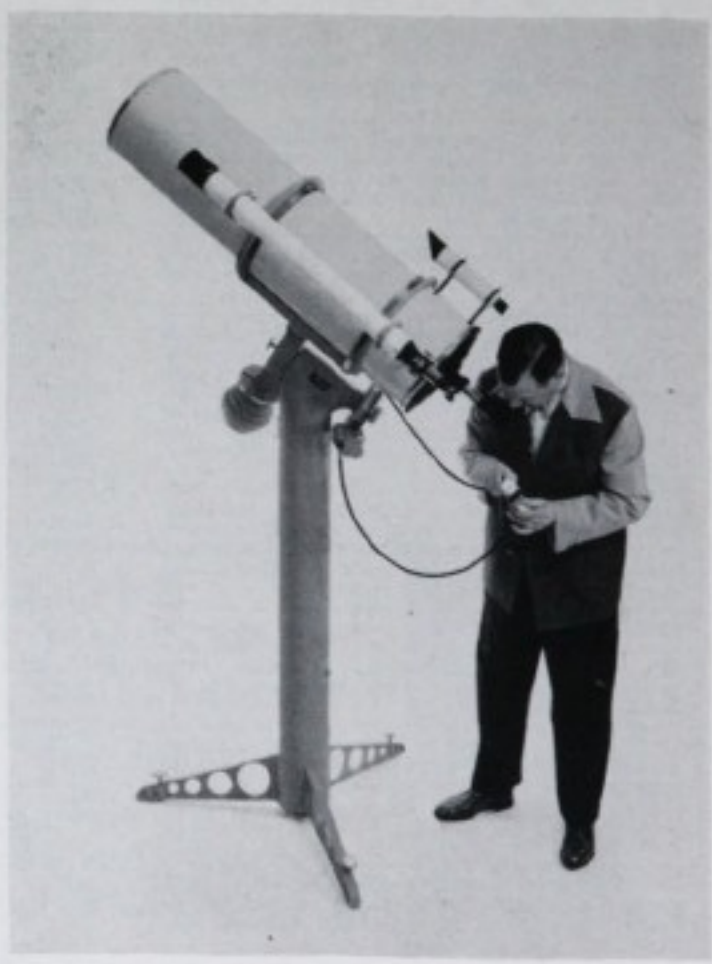

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A DAYTIME AURORA

On the late afternoon of March 27th I saw an auroral display in full daylight. This was indeed a surprise to me, for in his recent book, *The Polar Aurora*, Carl Störmer accepts as genuine only one report of a daylight aurora—seen in New Zealand.

At 5:00 p.m., Central standard time, long before the sun was to set, I was watching an airplane cross the sky. Then I noticed faint auroral rays extending to an altitude of 80 degrees. They were closely grouped and rippling toward the zenith, yellow-green, and seen very easily with averted vision. I could trace them to about 20 degrees on both sides of the magnetic meridian.

An hour later they were still present, but fainter, requiring averted vision, and extending to an altitude of only 50 or 60 degrees.

After sunset the rays were gone, but there was a bright glow on the northern horizon, and at 8:00 that evening thin ray bundles formed similar to those seen at 5 o'clock. By 9:00 p.m. the display was all gone.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

MINIMA OF ALGOL

June 3, 11:07; 6, 7:55; 9, 4:44; 12, 1:33; 14, 22:22; 17, 19:10; 20, 15:59; 23, 12:48; 26, 9:36; 29, 6:25. July 2, 3:14; 5, 0:02.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

SUNSPOT NUMBERS

March 1, 144, 153; **2**, 158, 164; **3**, 120, 137; **4**, 121, 127; **5**, 92, 125; **6**, 111, 146; **7**, 137, 146; **8**, 114, 143; **9**, 141, 180; **10**, 177, 186; **11**, 170, 210; **12**, 191, 224; **13**, 178, 228; **14**, 145, 164; **15**, 112, 161; **16**, 114, 146; **17**, 124, 155; **18**, 123, 148; **19**, 126, 150; **20**, 128, 110; **21**, 108, 128; **22**, 132, 137; **23**, 139, 152; **24**, 122, 145; **25**, 102, 160; **26**, 112, 171; **27**, 149, 154; 23, 143, 146; **29**, 135, 154; **30**, 139, 172; **31**, 132, 145. Means for March: 133.5 American, 157.0 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

Zurich provisional sunspot numbers are transmitted by the Swiss Broadcasting Corporation by short wave on the 4th and 5th of the following month. Listeners in North America can hear these reports the 5th of each month at 01:35 UT on wave lengths of 48.66, 31.46, 25.28, and 19.60 meters, and at 04:20 UT on 31.46, 25.28, and 19.60 meters. Reports beamed to South America at 23:30 UT on the 4th are on 31.46, 25.28, and 19.60 meters; and at 03:45 UT on the 5th on 31.46 and 25.28 meters. This schedule will be used until and including October, 1957.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Predictions for June were published last month on page 355.

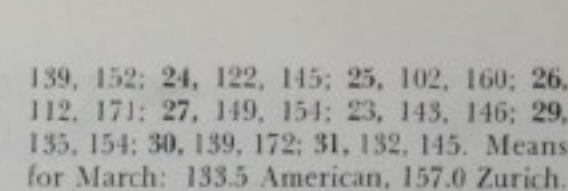
JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

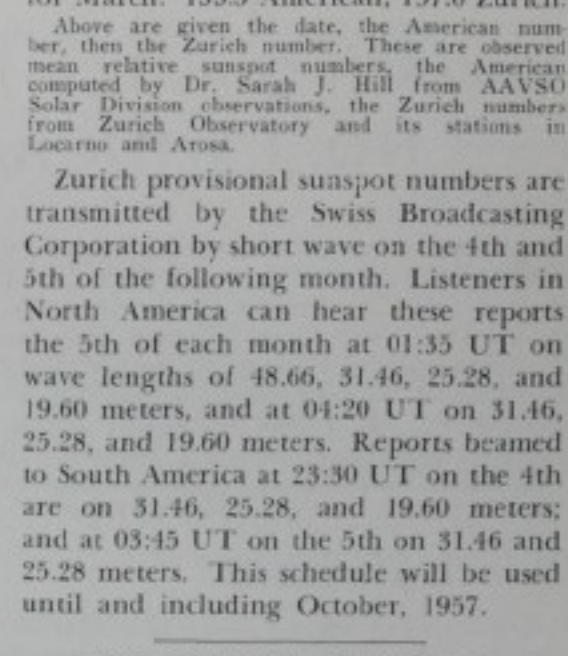
In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.

JUNE

Phases of the Eclipses of the Satellites



Configurations at 3h 40m



OCCULTATION PREDICTIONS

No stars brighter than magnitude 5.0 will be occulted in June, as seen from the stations for which *Sky and Telescope* publishes predictions.

SKY-GAZERS EXCHANGE

Classified advertising costs 20 cents a word, including address; minimum charge, $3.00 per ad. Only one *for sale* ad per issue for each advertiser. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the 20th of the second month before publication; otherwise, insertion will be made in next issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for statements made in classified ads, nor for the quality of merchandise advertised. Write Ad Dept., *Sky and Telescope*, Harvard Observatory, Cambridge 38, Massachusetts.

BIG spring sale of the wonderful Spacescope-Planet Seeker refractors, 2⅜"—$85.00, 3½"—$295.00, 4"—$395.00. See our display ad, December, 1956, issue, *Sky and Telescope*. Brayton Optical Exchange, 120 Beachway, Monterey, Calif.

8" REFLECTOR, complete unit, 4" refractor, Dallmeyer double-component rapid rectilinear objective. Authorized Bausch and Lomb, Zeiss, Hensoldt, Bushnell dealer. Tele-Optics, 5514 Lawrence Ave., Chicago 30, Ill.

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WANTED: Best new or used telescope, for astronomical and terrestrial viewing, adaptable to Leica or other camera, portable for use on mountaintops. Advise full details and price. Richard Cooke, Apartado 2021, Caracas, Venezuela.

PYREX MIRRORS: Hand ground and polished to order. Aluminized. From 6" to, and especially, 12". Guaranteed paraboloidal correction 90%. Send specifications to Dennis Moellman, 707 E. McKinley, Belleville, Ill.

FOR SALE: Unitron 2.4" altazimuth refractor, model No. 114, with all standard accessories plus erecting prism system, 40-mm. eyepiece. Purchased new a year ago for $158.25. Best offer. Louis Loewinger, C.P.A., 15 Park Row, New York 38, N. Y.

FOR SALE: *Sky and Telescope*, September, 1953, through September, 1956, $10.00. *Science News Letter*, 1954, 1955, 1956, $10.00. Excellent condition. Shirley M. Deal, 524 N. County St., Waukegan, Ill.

INTERESTED in astronomy as a career? *Vocational and Professional Monographs: Astronomy* by Freeman D. Miller describes personal qualifications, scholastic training, and job opportunities. $1.00 postpaid. Send to Box B, *Sky and Telescope*, Harvard Observatory, Cambridge 38, Mass.

TELESCOPE TUBES: Strong, durable, low cost, any size, any length. Send 3¢ stamp for information. F. Hudnall, 281 Rosslyn Ave., Worthington, Ohio.

NEW specially designed 4.1" refractor, 60" f.l. air-spaced objective. Aluminum construction. $550.00. Ernest Parker, 108 Phillips St., Stratford, Conn.

BEGINNER'S Telescope Kit: $3.00 each, all parts, and 3 lenses. Make 8-power astronomical telescope described in September, 1949, *Sky and Telescope*. Frank Myers, 19200 N. Park Blvd., Shaker Heights, Ohio.

RARE ITEMS: 6" portable folded refractor, described in *Scientific American*, May, 1948. Genuine historical John Brashear sturdy half-ton reflector for group or observatory. High-dispersion Hilger liquid prism for hydrogen-alpha. 2-prism wavelength spectrometer. Rangefinder end assemblies. High-power Barlows. 4-element anastigmatic erecting lenses. 5" f/5 rich-field achromat. 5 x 7 Graflex at price of 8½" Kodak anastigmatic lens. Write for details. Also hundreds of other rare and odd items, lenses, test flats, prisms, and so forth. No catalogues. Write on post card your needs or interests. Dr. H. E. Paul, 119 N. Broad St., Norwich, N. Y.

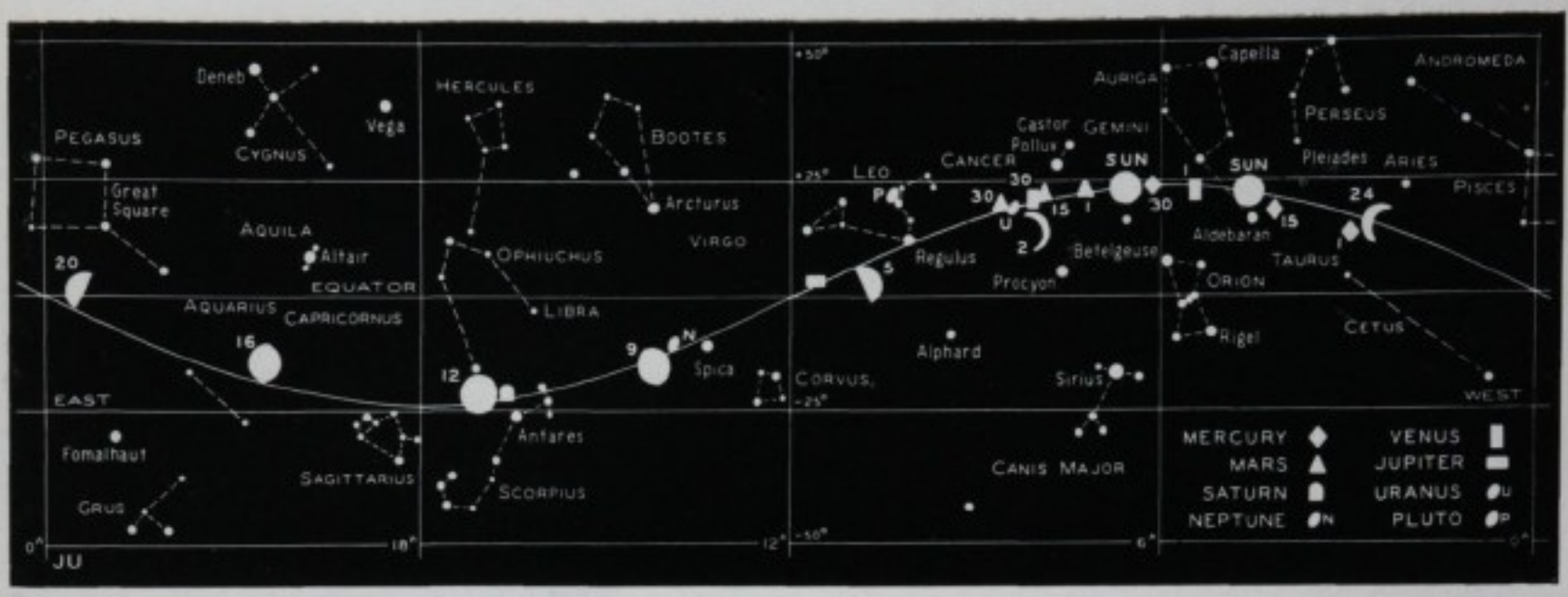
ASTROLA 12½" f/4, specially made with extra large finder and eyepiece holder. Clock drive with punch-block control both axes. 3 Davidson eyepieces mounted in turret. Will ship prepaid for $1,200.00. Photos available. Also 12½" f/5 combination Newtonian-Cassegrainian telescope, Caltech-Porter design, see page 449 *Amateur Telescope Making*. Excellent optics, pendulum-controlled clock drive, reversible electric slow-motion punch-block control for both axes. 3-power turret finder, 2 camera attachments, sun diagonal, solar eyepiece, projected reticle, 7 eyepieces. Replacement cost $8,000.00. Will crate and ship for $3,750.00. Photos available. B. A. Wacek, 2901 Remington Ave., Baltimore 11, Md.

SIDEREAL DRIVE plans for telescope or camera, accurate simple gearless design; make color transparencies; complete plans for $1.00. "Space Chart" of sun, moon, planets, asteroids, graphically proportioned, also constellation maps listing many stars, $1.00. L. Mussgnug, Box 74, Bethel, Conn.

FOR SALE: 8" reflecting telescope, f/8 mirror, ⅛-wave parabola. White fiberglass tube, rack-and-pinion focusing. Unitron finder. 2 orthoscopic eyepieces. Rigid equatorial mount, 2⅛" axes. 3" guide telescope ready to attach. Almost new, $330.00. Write Larry Odom, 630½ E. Orme, Wichita, Kans.

SKYLINE PORTO-SCOPE: A 6" f/8 reflecting telescope with ⅛-wave paraboloidal mirror, ⅛-wave elliptical diagonal, Snyder spider, fiberglass tube, 7 x 50 fully coated achromatic right-angle finder with crosshairs, 3 Ramsden oculars (50x, 100x, 200x), fine-thread focuser, light but sturdy aluminum tripod and mount, slow motion both axes. Only $175.00 f.o.b. Quality Optics, Walbridge, Ohio.

REFLECTING TELESCOPE, 4¼", mirror 90% corrected, slow-motion controls, equatorial mounting, tripod, finder, eyepieces of 57x, 110x, 190x. $70.00 postpaid. B. Gilligan, 1205 Neptune Ave., Akron 1, Ohio.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0h Universal time on the respective dates.

Mercury is in the morning sky during the first half of June, rising about one hour before the sun. On the 1st, when it reaches greatest western elongation nearly 25° from the sun, its apparent magnitude is +0.8.

Venus appears as a brilliant evening object, but rather close to the sun and setting during twilight; not until October will it become really prominent. Its phase at the present time is practically full, 96 per cent of its disk being illuminated, and its telescopic diameter is only about 5″.

Earth arrives at heliocentric longitude 270° on June 21st at 16:21 UT, when summer commences in the Northern Hemisphere, winter in the Southern.

Mars, an inconspicuous 2nd-magnitude object near the Gemini-Cancer border, sets about two hours after the sun on June 15th. In binoculars, a large triangle will be seen in the evening twilight on June 29th, when Mars and the two-day-old crescent moon will be nearly in conjunction, with the moon about 6° south of the planet, and Venus will be some 7° farther west. Mars itself is to be in conjunction with Uranus that evening.

Jupiter continues to dominate the evening sky, as eastern quadrature with the sun occurs on June 14th. The planet is on the western border of Virgo, of magnitude −1.6, with an equatorial diameter of 36″.7 in the middle of the month. Its four bright satellites can be identified with the aid of the chart on page 400.

Saturn rises just at sunset, for it is in opposition to the sun on June 1st, when the Earth-Saturn distance will be about 840 million miles. The planet shines at magnitude +0.2, in western Ophiuchus. Its rings are inclined 25°.9 to our line of sight, with their longest apparent diameter 41″.7. On June 11th, at 13:57 UT, during daytime in the United States, there will be a very close conjunction of the full moon and Saturn. The moon and the planet should form a beautiful configuration as they set that morning.

Uranus, located west of the Beehive cluster in Cancer, can be seen with slight optical aid, but it is low in the western sky as twilight ends. A conjunction of Uranus and Mars will occur during evening twilight of June 29th, with Mars only 40′ north of Uranus, but observing this event will require a clear western horizon and good binoculars or a small telescope. This is the occasion of the Mars-Venus-Moon triangle, described previously under Mars.

Neptune is near the meridian at sunset, and may be located with good binoculars. Its position in mid-June will be 13h 54m, −9° 48′, about 4° west of Kappa Virginis. E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

VARIABLE STAR MAXIMA

June 7, W Lyrae, 181136, 8.0; 12, R Pegasi, 230110, 7.9; 14, RS Librae, 151822, 7.7; 18, RV Sagittarii, 182133, 7.8; 21, S Coronae Borealis, 151731, 7.5; 30, X Centauri, 114441, 7.8; 30, S Pegasi, 231508, 8.0.

July 3, R Canum Venaticorum, 134440, 7.7; 5, U Herculis, 162119, 7.6; 6, Chi Cygni, 194632, 5.3; 10, R Bootis, 143227, 7.3; 10, V Bootis, 142539, 7.9; 10, U Ceti, 022813, 7.5.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MOON PHASES AND DISTANCE

First quarter	June 5,	7:10
Full moon	June 12,	10:02
Last quarter	June 20,	10:22
New moon	June 27,	20:53
First quarter	July 4,	12:09

	June	Distance	Diameter
Perigee	3, 4h	229,100 mi.	32′ 25″
Apogee	18, 11h	251,500 mi.	29′ 32″
Perigee	30, 8h	226,100 mi.	32′ 50″
	July		
Apogee	16, 3h	251,900 mi.	29′ 28″

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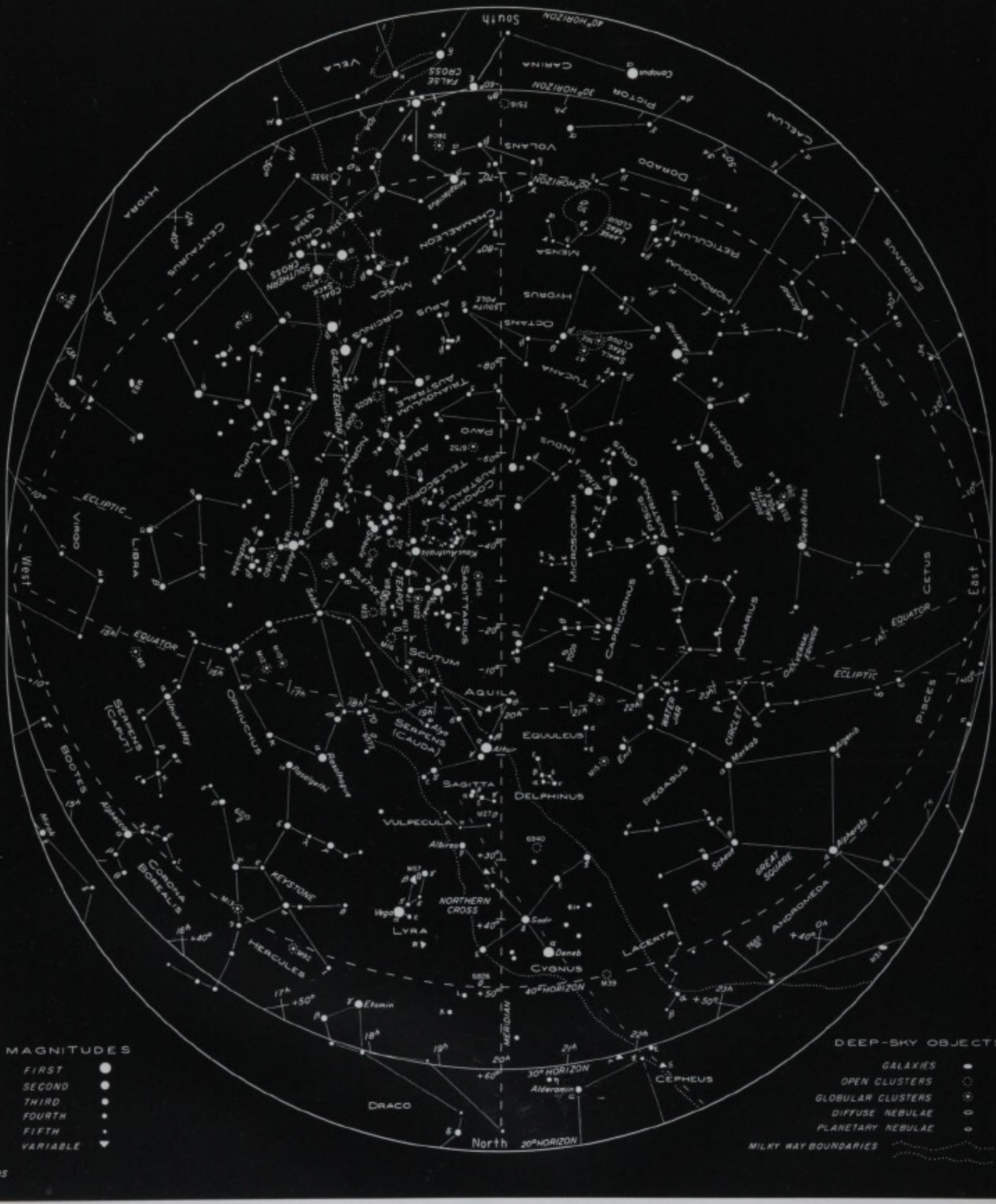
South
40° HORIZON
30° HORIZON
20° HORIZON
North
West
East
MERIDIAN
ECLIPTIC
EQUATOR
VELA
CARINA
Canopus
PICTOR
CAELUM
DORADO
VOLANS
RETICULUM
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ERIDANUS
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Spica
SCORPIUS
Antares
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Large Cloud
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Alcor
Polaris
Algol
Capella
Rigel
Betelgeuse
Procyon
Sirius
Canopus
Achernar
Alphard
Regulus
Spica
Arcturus
Antares
Vega
Altair
Deneb
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Alderamin
Markab
Schedar
Algenib
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Mirach
Almach
Hamal
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Sirius
Canopus
Achernar
Hadar
Agena
Rigil Kentaurus
Atria
Nunki
Ascella
Kaus Australis
Deneb Kaitos
Fomalhaut

STARS FOR JUNE

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 22nd of June, respectively. For other dates, add or subtract ½ hour per week.

For observing at later hours on these June nights, use charts of other months. The following times apply to the 7th and 22nd, but all the charts are usable throughout the month: July chart for 11 p.m. and 10 p.m.; August, 1 a.m. and midnight; and the September chart, 3 a.m. and 2 a.m.

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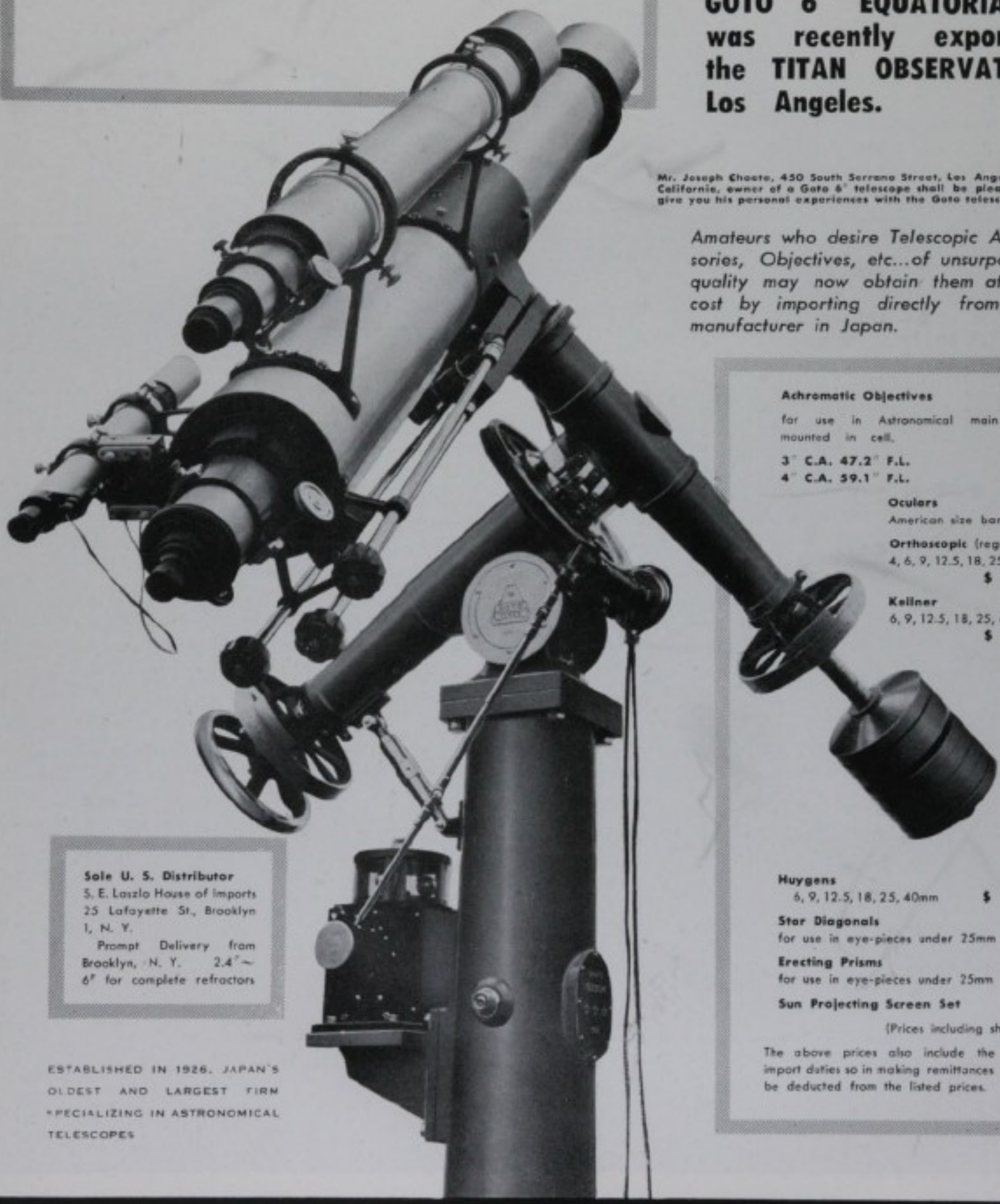

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American size barrel.

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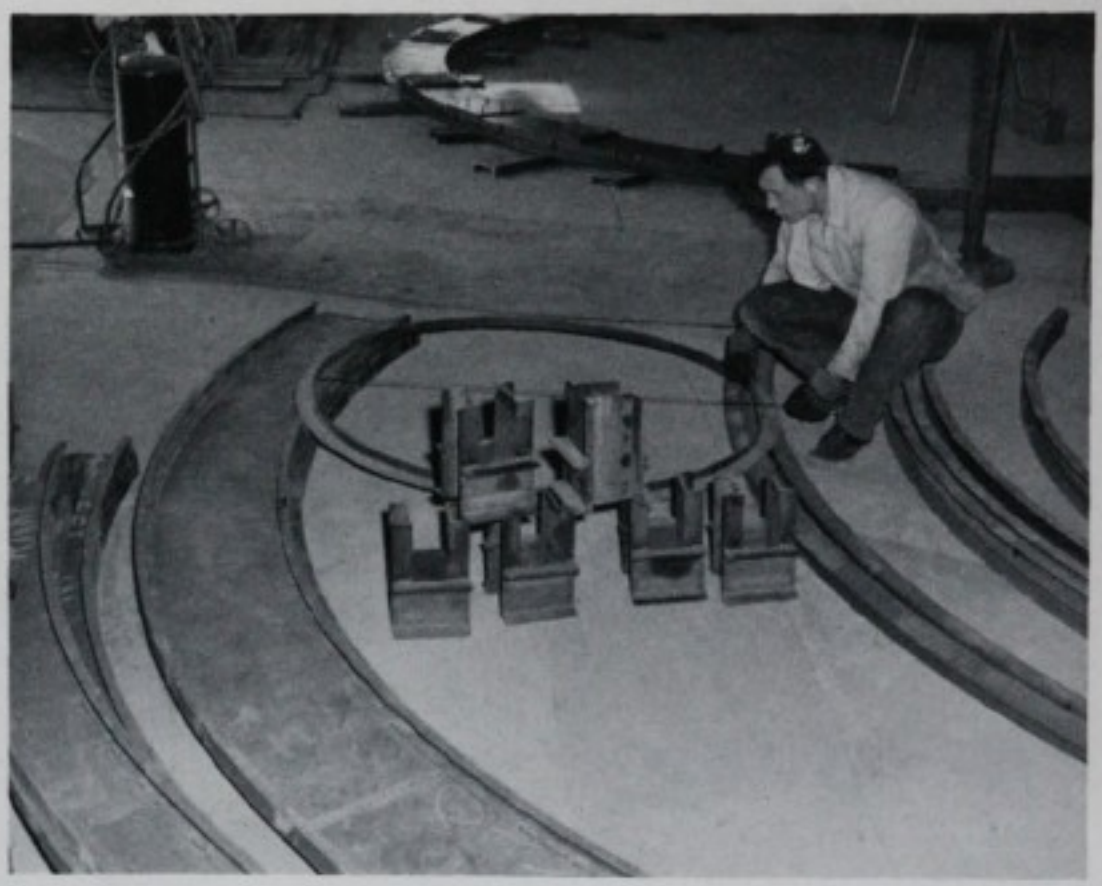

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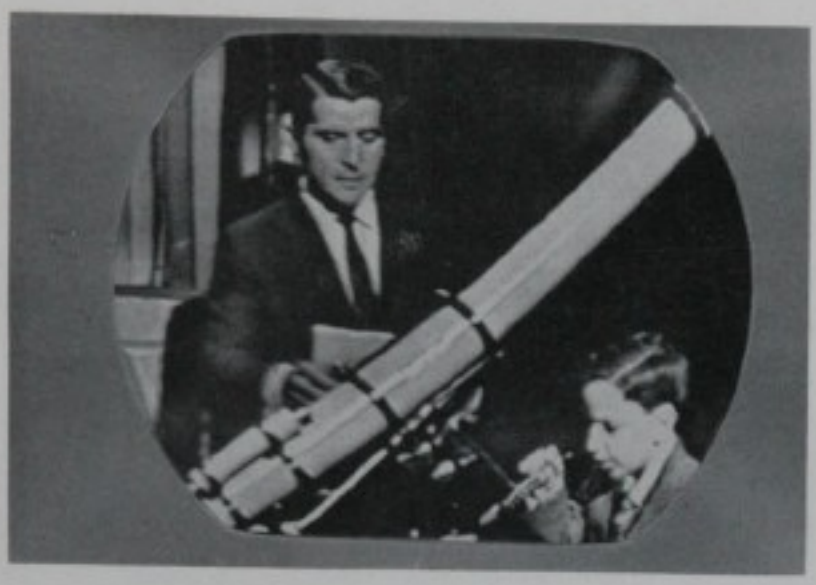
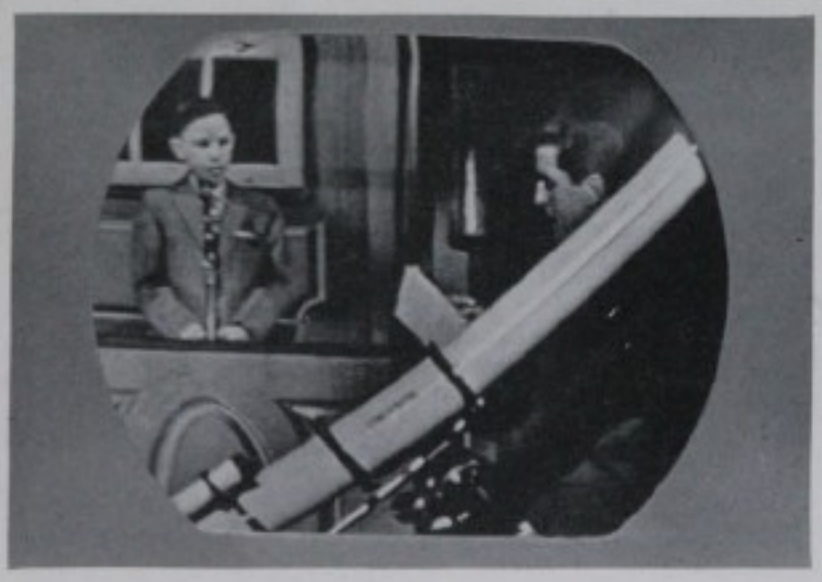
UNITRON TUNES IN "THE $64,000 QUESTION"

Robert Strom Wins Again on Revlon's TV Quiz Program





Had an extraterrestrial observer been watching the earth on the evening of March 19-20, he would probably have been puzzled at the sight of droves of astronomers leaving their instruments at 2:00 Universal time and moving indoors. But there was nothing strange about this behavior for, at that time, 10-year-old amateur astronomer Robert Strom of the Bronx, New York, was scheduled to make another appearance on the CBS television program, "The $64,000 Question."

Interest in the program was especially high that evening since Robert, who had already won $64,000, was on his way to a possible winning of double, triple, and quadruple that amount. If successful, he would be the first TV contestant ever to be so rewarded.

For the major part of the question of the evening, a UNITRON 3" Equatorial Refractor, Model 142, was brought on stage, and Robert was asked to note the readings on the setting circles. "A mighty fine telescope," commented Robert graciously. Following this unscheduled demonstration of his astronomical acumen, Robert entered the "isolation booth" to receive the question posed by Hal March, the master of ceremonies. "This is a UNITRON equatorially mounted telescope . . . with these settings . . . and with a sidereal time of 10 hours, tell me what point in the sky you would be looking at through the telescope?"

Robert took the question in stride — confirming the ancient adage that the first $64,000 is the hardest — and explained that the UNITRON would be aimed at the constellation Virgo and, more precisely, at the September equinox. Another $16,000 had been added to his accumulated winnings.

Large and unfamiliar numbers are often difficult to visualize. As a pedagogical aid, it may be helpful to point out that for $16,000 one could buy 128 UNITRON 2.4" Altazimuth Refractors, Model 114. Similarly, for $64,000, you could obtain 512 Model 114's and, indirectly, 511 friends. The number of 114's which $256,000 would command will be left as a problem for the student.

Robert has since reached the "triple plateau" with winnings of $192,000. His TV appearances have served to emphasize the valuable training that the youngsters of today acquire through the devoted pursuit of their hobbies. We all wish Robert the best of luck in his future scientific career.

See pages 388 and 389.

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